Quasinormal Modes Of Black Holes, Quasinormal Spectrum And The Black Hole Membrane, Zero Sound From Holography, Relativistic Viscous Hydrodynamics, Conformal Invariance, And Holography, Supersymmetric Yang-Mills Plasma, Dense Chern-Simons Matter With Fermions, Hydrodynamics On The Lowest Landau Level, Curved Non-Relativistic Spacetimes And Newtonian Gravitation, Spacetime Symmetries Of The Quantum Hall Effect, Pseudo-Supersymmetric Quantum Mechanics, Holographic Description Of A Quantum Black Hole On A Computer, Matrix Perturbation Theory For M-Theory, Supersymmetric Yang–Mills Quantum Mechanics, Matrix Quantum Mechanics As A Fundamental Theory, Alignment Limit In Two-Higgs-Doublet Model And Other Colloquiums, Editorials And Executive Expositions With Similar Interest Propensities Thereof: Cogitationis Poenam Nemo Patitur Nobody Suffers Punishment For Mere Intent Delegatus Non Potest Delegare That Which Has Been Delegated, Cannot Delegate [Further] Dubia In Meliorem Partem Interpretari Debent Doubtful Things Should Be Interpreted In The Best Way Often Spoken As "To Give The Benefit Of The Doubt." Expressio Unius Est Exclusio Alterius ("The Express Mention Of One Thing Excludes All Others") Items Not On The List Are Impliedly Assumed Not To Be Covered By The Statute Or A Contract Term.[3] However, Sometimes A List In A Statute Is Illustrative, Not Exclusionary. This Is Usually Indicated By A Word Such As "Includes" Or "Such As.": Entia Non Sunt Multiplicanda Praeter Necessitatem-Entities Must Not Be Multiplied Beyond Necessity Occam's Razor Or Law Of Parsimony; That Is, That Arguments Which Do Not Introduce Extraneous Variables Are To Be Preferred In Logical Argumentation- Models

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ABSTRACT

Abstract: Using the anti–de Sitter/conformal field theory correspondence, **G. Policastro, D. T. Son, and A. O. Starinets** relate the shear viscosity η of the finite-temperature N=4 supersymmetric Yang-Mills theory in the large N, strong-coupling regime with (e&eb) the absorption cross section of (e) low-energy gravitons by (e) a near-extremal black three-brane. **G. Policastro, D. T. Son, and A. O. Starinets** show that in the limit of zero frequency this cross section coincides with (=) the area of the horizon. From this result they find η=π8N2T3. They conjecture that for finite't Hooft coupling g2YMN the shear viscosity is (=) η=f(g2YMN)N2T3, where f(x) is a monotonic function that decreases from O(x−2ln−1(1/x)) at small x to π/8 when x→∞. Received 14 April 2001 DOI: http://dx.doi.org/10.1103/PhysRevLett.87.081601 **Shear Viscosity of Strongly Coupled N=4 Super symmetric Yang-Mills Plasma G. Policastro, D. T. Son, and A. O. Starinets Phys. Rev. Lett. 87, 081601 – Published 2 August 2001 STOP** Authors use the AdS/CFT correspondence to determine the rate of energy loss of a heavy quark moving through (e&eb) Script N = 4 SU (Nc) super symmetric Yang-Mills plasma at large't Hooft coupling. Using the dual description of the quark as a classical string ending on a D7-brane, **Christopher P. Herzog1, Andreas Karch1, Pavel Kovtun2, Can Kozcaz1 and Laurence G. Yaffe1** use a complementary combination of analytic and numerical techniques to determine (eb) the friction coefficient as a function of quark mass. Provided strongly coupled Script N = 4 Yang-Mills plasma is (=) a good model for hot, strongly coupled QCD, results may be relevant for (e) charm and bottom physics at RHIC. **Energy loss of a heavy quark moving through Script N = 4 super symmetric Yang-Mills plasma Christopher P. Herzog1, Andreas Karch1, Pavel Kovtun2, Can Kozcaz1 and Laurence G. Yaffe1 Published 11 July 2006 Journal of High Energy Physics, Volume 2006, JHEP07(2006) STOP Benjamin Svetitsky** calculates the classical drag and diffusion coefficients for (e) a charmed quark propagating in the quark-gluon plasma. Both coefficients turn out rather large, so that (1) a charmed quark created when (e) the plasma is hot will be (=) stopped before propagating 1 fm and (2) subsequent diffusion will be fast. The first effect should serve to (e) increase the yield of J/ψ mesons in (eb) relativistic heavy-ion collisions, while the second should work in the opposite direction. In any case, the two effects should dominate (e) the dynamics of a cc¯ pair. Received 16 November 1987 DOI: http://dx.doi.org/10.1103/PhysRevD.37.2484 **Diffusion of charmed quarks in the quark-gluon plasma Benjamin Svetitsky Phys. Rev. D 37, 2484 – Published 1 May 1988 STOP** Using holographic duality, authors present results for (e) both head-on and off-center collisions of Gaussian shock waves in (eb) strongly coupled N=4 supersymmetric Yang-Mills theory. The shock waves superficially resemble (e&eb) Lorentz contracted colliding protons. The collisions results in (eb) the formation of a plasma whose evolution is well described by (e) viscous hydrodynamics. The size of the produced droplet is R∼1/Teff where (e) Teff is the effective temperature, which is (=) the characteristic microscopic scale in strongly coupled plasma. These results demonstrate (eb) the applicability of hydrodynamics to microscopically small systems and bolster (eb) the notion that hydrodynamics can be applied to (e&eb) heavy-light ion collisions as well as some proton-proton collisions. Subjects: High Energy Physics - Theory (hep-th); General Relativity and Quantum Cosmology (gr-qc); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) Cite as: arXiv: 1601.01583 [hep-th] (or arXiv: 1601.01583v2 [hep-th] for this version) **How big are the smallest drops of quark-gluon plasma? Paul M. Chesler STOP Paul M. Chesler, Krishna Rajagopal** calculate how the energy and (e&eb) the opening angle of jets in N=4 SYM theory evolve as they propagate through (e&eb) the strongly coupled plasma of that theory. **Paul M. Chesler, Krishna Rajagopal** define the rate of energy loss dEjet/dx and (e&eb) the jet opening angle in a straightforward fashion directly in the gauge theory before (e) calculating both holographically, in (eb) the dual gravitational description. In this way, authors rederive the previously known result for (e) dEjet/dx without (e) the need to introduce (e&eb) a finite slab of plasma. They obtain a striking relationship between the initial opening angle of the jet, which is to say the opening angle that it would have had if it had found itself in vacuum instead of in plasma, and (e&eb) the thermalization distance of the jet. Via this relationship, they show that N=4 SYM jets with (e&eb) any initial energy that have the same initial opening angle and the same trajectory through (e&eb) the plasma experience the same fractional energy loss. They also provide an expansion that describes how the opening angle of the N=4 SYM jets increases slowly as they lose energy, over the fraction of their lifetime when their fractional energy loss is not yet large. We close by looking ahead toward potential qualitative lessons from our results for QCD jets produced in heavy collisions and propagating through quark-gluon plasma. Subjects: High Energy

Physics - Theory (hep-th); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) Cite as: arXiv: 1511.07567 [hep-th] (or arXiv:1511.07567v2 [hep-th] for this version) **On the Evolution of Jet Energy and Opening Angle in Strongly Coupled Plasma Paul M. Chesler, Krishna Rajagopal STOP Paul M. Chesler, Niki Kilbertus, Wilke van der Schee study** the collision of planar shock waves in AdS5 as a function of shock profile. In the dual field theory the shock waves describe planar sheets of energy whose collision results in the formation of a plasma which behaves hydrodynamically at late times. They find that the post-collision stress tensor near the light cone exhibits transient non-universal behavior which depends on both the shock width and the precise functional form of the shock profile. However, over a large range of shock widths, including those which yield qualitative different behavior near the future light cone, and for different shock profiles, we find universal behavior in the subsequent hydrodynamic evolution. Additionally, we compute the rapidity distribution of produced particles and find it to be well described by a Gaussian. Subjects: High Energy Physics - Theory (hep-th); General Relativity and Quantum Cosmology (gr-qc); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) DOI: 10.1007/JHEP11 (2015)135 Cite as: arXiv: 1507.02548 [hep-th] (or arXiv: 1507.02548v2 [hep-th] for this version) **Universal hydrodynamic flow in holographic planar shock collisions Paul M. Chesler, Niki Kilbertus, Wilke van der Schee STOP** Using numerical holography, we study the collision, at non-zero impact parameter, of bounded, localized distributions of energy density chosen to mimic relativistic heavy ion collisions, in strongly coupled N = 4 supersymmetric Yang-Mills theory. Both longitudinal and transverse dynamics in the dual field theory are properly described. Using the gravitational description we solve 5D Einstein equations, without dimensionality reducing symmetry restrictions, to find the asymptotically anti-de Sitter spacetime geometry. Implications of **Paul M. Chesler, Laurence G. Yaffe** results on the understanding of early stages of heavy ion collisions, including the development of transverse radial flow, are discussed. Comments: Enlarged JHEP version, 14 pages Subjects: High Energy Physics - Theory (hep-th); General Relativity and Quantum Cosmology (gr-qc); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) Cite as: arXiv: 1501.04644 [hep-th] (or arXiv:1501.04644v2 [hep-th] for this version) **Holography and off-center collisions of localized shock waves Paul M. Chesler, Laurence G. Yaffe STOP Paul M. Chesler, Antonio M. Garcia-Garcia, Hong Liu** study the dynamic after a smooth quench across a continuous transition from the disordered phase to the ordered phase. Based on scaling ideas, linear response and the spectrum of unstable modes, we develop a theoretical framework, valid for any second order phase transition, for the early-time evolution of the condensate in the broken phase. Their analysis unveils a novel period of non-adiabatic evolution after the system passes through the phase transition, where a parametrically large amount of coarsening occurs before a well-defined condensate forms. Formalism predicts a rate of defect formation parametrically smaller than the Kibble-Zurek prediction and yields a criterion for the break-down of Kibble-Zurek scaling for sufficiently fast quenches. **Paul M. Chesler, Antonio M. Garcia-Garcia, Hong Liu** numerically test our formalism for a thermal quench in a 2 + 1 dimensional holographic superfluid. These findings, of direct relevance in a broad range of fields including cold atom, condensed matter, statistical mechanism and cosmology, are an important step towards a more quantitative understanding of dynamical phase transitions. Subjects: High Energy Physics - Theory (hep-th); Quantum Gases (cond-mat.quant-gas); Statistical Mechanics (cond-mat.stat-mech) Journal reference: Phys. Rev. X 5, 021015 (2015) DOI: 10.1103/PhysRevX.5.021015 Cite as: arXiv:1407.1862 [hep-th] (or arXiv:1407.1862v2 [hep-th] for this version) **Defect formation beyond Kibble-Zurek mechanism and holography Paul M. Chesler, Antonio M. Garcia-Garcia, Hong Liu STOP Paul M. Chesler, Krishna Rajagopal** present calculations in which an energetic light quark shoots through a finite slab of strongly coupled N=4 supersymmetric Yang-Mills (SYM) plasma, with thickness L, focussing on what comes out on the other side. We find that even when the "jets" that emerge from the plasma have lost a substantial fraction of their energy they look in almost all respects like "jets" in vacuum with the same reduced energy. The one possible exception is that the opening angle of the "jet" is larger after passage through the slab of plasma than before. Along the way, we obtain a fully geometric characterization of energy loss in the strongly coupled plasma and show that dEout/dL∝L2/x2stop−L2−−−−−−−√, where Eout is the energy of the "jet" that emerges from the slab of plasma and xstop is the (previously known) stopping distance for the light quark in an infinite volume of plasma. Subjects:

High Energy Physics - Theory (hep-th); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) Journal reference: Phys. Rev. D 90, 025033 (2014) DOI: 10.1103/PhysRevD.90.025033 Cite as: arXiv:1402.6756 [hep-th] (or arXiv:1402.6756v1 [hep-th] for this version) **Jet quenching in strongly coupled plasma Paul M. Chesler, Krishna Rajagopal STOP** Quasinormal modes are (=) eigenmodes of dissipative systems. Perturbations of classical gravitational backgrounds involving (e&eb) black holes or branes naturally lead to (eb) quasinormal modes. The analysis and classification of (e) the quasinormal spectra require solving (e) non-Hermitian eigenvalue problems for (e) the associated linear differential equations. Within the recently developed gauge-gravity duality, these modes serve as (=) an important tool for (e) determining the near-equilibrium properties of (e) strongly coupled quantum field theories, in particular their transport coefficients, such as (=) viscosity, conductivity and diffusion constants. In astrophysics, the detection (e&eb) of quasinormal modes in gravitational wave experiments would allow (eb) precise measurements of (e) the mass and spin of black holes as well as new tests of general relativity. This review is meant as an introduction to the subject, with a focus on the recent developments in the field. **Quasinormal modes of black holes and black branes Emanuele Berti1,2, Vitor Cardoso1,3 and Andrei O Starinets4 Published 24 July 2009 • 2009 IOP Publishing Ltd Classical and Quantum Gravity, Volume 26, Number 16 STOP Gary T. Horowitz and Veronika E. Hubeny** investigate the decay of a scalar field outside (e) a Schwarzschild anti–de Sitter black hole. This is determined by computing (e&eb) the complex frequencies associated with (e&eb) quasinormal modes. There are qualitative differences from (e) the asymptotically flat case, even in (eb) the limit of small black holes. In particular, for a given angular dependence, the decay is (=) always exponential—there are (=) no power law tails at late times. In terms of the AdS-CFT correspondence, a large black hole corresponds to (e&eb) an approximately thermal state in the field theory, and the decay of the scalar field corresponds to (e&eb) the decay of a perturbation of this state. Thus one obtains the time scale for the approach to (e) thermal equilibrium. **Gary T. Horowitz and Veronika E. Hubeny** compute (e&eb) these time scales for the strongly coupled field theories in three, four, and six dimensions, which are (=)dual to string theory in asymptotically AdS spacetimes. Received 27 September 1999 DOI: http://dx.doi.org/10.1103/PhysRevD.62.024027 **Quasinormal modes of AdS black holes and the approach to thermal equilibrium Gary T. Horowitz and Veronika E. Hubeny Phys. Rev. D 62, 024027 – Published 27 June 2000 STOP** Gravitational waves emitted by (e) perturbed black holes or relativistic stars are dominated by (e) `quasinormal ringing', damped oscillations at (eb) single frequencies which are (=) characteristic of the underlying system. These quasinormal modes have been studied for (e) a long time, often with the intent of describing the time evolution of (e) a perturbation in terms of (e&eb) these modes in a way very similar to a normal-mode analysis. In this review, authors summarize how quasinormal modes are defined and computed. **Hans-Peter Nollert** finds why they have been regarded as closely analogous to normal modes, and discovers why they are actually quite different. Authors also discuss how quasinormal modes can be used in (eb) the analysis of a gravitational wave signal, such as will hopefully be detected in (e&eb) the near future. **Quasinormal modes: the characteristic `sound' of black holes and neutron stars Hans-Peter Nollert STOP** Perturbations of black holes, initially considered in the context of possible observations of astrophysical effects, have been studied for the past 10 years in string theory, brane-world models, and quantum gravity. Through the famous gauge/gravity duality, proper oscillations of (e) perturbed black holes, called quasinormal modes, allow (eb) for the description of (e) the hydrodynamic regime in (eb) the dual finite temperature field theory at (eb) strong coupling, which can be used to (e) predict the behavior of quark-gluon plasmas in (eb) the nonperturbative regime. On the other hand, the brane-world scenarios assume (eb) the existence of extra dimensions in nature, so that (e) multidimensional black holes can be formed in (eb) a laboratory experiment. All this stimulated active research in the field of perturbations of (e) higher-dimensional black holes and branes during recent years. In this review recent achievements on various aspects of black hole perturbations are discussed such as decoupling of variables in the perturbation equations, quasinormal modes (with special emphasis on various numerical and analytical methods of calculations), late-time tails, (e&eb) gravitational stability, (e&eb) anti–de Sitter/conformal field theory interpretation of (e) quasinormal modes, and holographic superconductors. Authors also touch on state-of-the-art observational possibilities for (e) detecting quasinormal modes of black holes. DOI: http://dx.doi.org/10.1103/RevModPhys.83.793 © 2011 American Physical Society **Quasinormal modes of**

black holes: From astrophysics to string theory R. A. Konoplya and Alexander Zhidenko Rev. Mod. Phys. 83, 793 – Published 11 July 2011 STOP Vitor Cardoso and José P. S. Lemos study the quasinormal modes (QNM) of electromagnetic and gravitational perturbations of a Schwarzschild black hole in (eb) an asymptotically anti–de Sitter (AdS) spacetime. Some of the electromagnetic modes do not (e) oscillate; they only decay, since they have (e) pure imaginary frequencies. The gravitational modes show (eb) peculiar features: the odd and even gravitational perturbations no longer have (e) the same characteristic quasinormal frequencies. There is a special mode for odd perturbations whose behavior differs completely from (e) the usual one in scalar and electromagnetic perturbations in AdS spacetime, but has a similar behavior to the Schwarzschild black hole in an asymptotically flat spacetime: the imaginary part of the frequency goes as 1/r+, where r+ is the horizon radius. **Vitor Cardoso and José P. S. Lemos** also investigate the small black-hole limit showing that the imaginary part of the frequency goes as r2+. These results are important to the AdS/CFT conjecture since, according to it, the QNM's describe the approach to equilibrium in the conformal field theory. Received 12 April 2001 DOI: http://dx.doi.org/10.1103/PhysRevD.64.084017 **STOP Gianluca Calcagni** studies the ultraviolet complete non-relativistic theory recently proposed by Hořava. After introducing a Lifshitz scalar for a general background, authors analyze the cosmology of (e) the model in Lorentzian and Euclidean signature. Vacuum solutions are found and it is argued the existence of (e) non-singular bouncing profiles. They find a general qualitative agreement with both the picture of Causal Dynamical Triangulations and (e&eb) Quantum Einstein Gravity. However, inflation driven by (e) a Lifshitz scalar field on a classical background might not (e) produce a scale-invariant spectrum when (e) the principle of detailed balance is assumed. **Cosmology of the Lifshitz universe Gianluca Calcagni Published 25 September 2009 • Journal of High Energy Physics, Volume 2009, JHEP09 (2009) STOP Petr Hořavaa, , Edward Wittenb** propose that the ten-dimensional E8 × E8 heterotic string is related to an eleven-dimensional theory on the orbifold Full-size image (<1 K) in the same way that the Type IIA string in ten dimensions is related to Full-size image (<1 K). This in particular determines the strong coupling behavior of the ten-dimensional E8 × E8 theory. It also leads to a plausible scenario whereby duality between SO (32) heterotic and Type I superstrings follows from the classical symmetries of the eleven-dimensional world, just as (=) the Full-size image (<1 K) duality of the ten-dimensional Type IIB theory follows from eleven-dimensional diffeomorphism invariance. **Heterotic and Type I string dynamics from eleven dimensions Petr Hořavaa, , Edward Wittenb, Nuclear Physics B Volume 460, Issue 3, 12 February 1996, Pages 506–524 STOP Petr Hořava1** proposes a quantum theory of membranes designed such that (e) the ground-state wavefunction of the membrane with (e&eb) compact spatial topology Σh reproduces (eb) the partition function of the bosonic string on (e&eb) worldsheet Σh. The construction involves (e&eb) worldvolume matter at (eb) quantum criticality, described in the simplest case by (e) Lifshitz scalars with (e&eb) dynamical critical exponent z = 2. This matter system must be coupled to (e&eb) a novel theory of worldvolume gravity, also exhibiting (eb) quantum criticality with z = 2. Authors first construct such a nonrelativistic ``gravity at a Lifshitz point'' with z = 2 in D+1 spacetime dimensions, and then specialize to (e&eb) the critical case of D = 2 suitable for the membrane worldvolume. They also show that (eb) in the second-quantized framework, the string partition function is reproduced if (e) the spacetime ground state takes the form of (e) a Bose-Einstein condensate of membranes in (eb) their first-quantized ground states, correlated across all general. **Membranes at quantum criticality Petr Hořava1, 2 Published 4 March 2009 • Journal of High Energy Physics, Volume 2009, JHEP03 (2009)STOP Petr Hořava** presents a candidate quantum field theory of gravity with (e&eb) dynamical critical exponent equal to z=3 in the UV. (As in condensed-matter systems, z measures (eb) the degree of anisotropy between space and time.) This theory, which at short distances describes (eb) interacting nonrelativistic gravitons, is (=) power-counting renormalizable in (eb) 3+1 dimension. When restricted to satisfy the condition of detailed balance,(eb) this theory is intimately related to (e&eb) topologically massive gravity in three dimensions, and the geometry of (e) the Cotton tensor. At long distances, this theory flows (e&eb) naturally to the relativistic value z=1, and could therefore serve as (=) a possible candidate for (e) a UV completion of Einstein's general relativity or an infrared modification thereof. The effective speed of light, the Newton constant and the cosmological constant all emerge from (e) relevant deformations of the deeply nonrelativistic z=3 theory at short distances. **Quantum gravity at a Lifshitz point Petr Hořava Phys. Rev. D 79, 084008 – Published 6 April**

2009STOP Black holes appear to conform to (e) a very straightforward generalisation of standard laboratory thermodynamics. This generalised theory is examined in detail, and some concrete results are presented. The thermodynamic connection is based on (e) Hawking's application of quantum theory to (e) black holes, and the quantum aspects are described in detail from (e) several standpoints, both heuristic and otherwise. The precise mechanism by which the black hole produces thermal radiation, its nature and origin, and the energetics of back-reaction on the hole are reviewed. The thermal states of quantum holes are also treated using (e) the theory of thermal Green functions, and the entropy of the hole is shown to be related to (e&eb) the loss of information about the quantum states hidden (e) behind the event horizon. Some related topics such as accelerated mirrors and (e&eb) observers in Minkowski space; (e&eb) super-radiance from rotating holes and the thermodynamics of general self-gravitating systems are also briefly discussed. **Thermodynamics of black holes P C W Davies Reports on Progress in Physics, Volume 41, and Number STOP D. Blasa, O. Pujolàsb and S. Sibiryakova,c** address the consistency of Hořava's proposal for a theory of quantum gravity from the low-energy perspective. They uncover the additional scalar degree of freedom arising from (e) the explicit breaking of the general covariance and study its properties. The analysis is performed both in (eb) the original formulation of the theory and in (eb) the Stückelberg picture. A peculiarity of the new mode is that it satisfies (eb) an equation of motion that is of (e) first order in time derivatives. At linear level the mode is manifest only around (e&eb) spatially inhomogeneous and time-dependent backgrounds. Authors find two serious problems associated with (e&eb) this mode. First, the mode develops (eb) very fast exponential instabilities at (eb) short distances. Second, it becomes (eb) strongly coupled at (eb) an extremely low cutoff scale. They also discuss the ``projectable'' version of (e) Hořava's proposal and argue that this version can be understood as (=) a certain limit of the ghost condensate model. The theory is still problematic since (e) the additional field generically forms (eb) caustics and, again, has a very low strong coupling scale. Authors clarify some subtleties that arise in (eb) the application of the Stückelberg formalism to Hořava's model due to its non-relativistic nature. **On the extra mode and inconsistency of Hořava gravity D. Blasa, O. Pujolàsb and S. Sibiryakova,c Published 12 October 2009 • Journal of High Energy Physics, Volume 2009, JHEP10(2009) STOP Vaibhav Madhok, Vibhu Gupta, Denis-Alexandre Trottier, and Shohini Ghose** identify signatures of chaos in the dynamics of discord in a multiqubit system collectively modelled as a quantum kicked top. Evolution of discord between any two qubits is quasiperiodic in regular regions, while (e) in chaotic regions the quasiperiodicity is lost. As the initial wave function is varied from (e) the regular regions to the chaotic sea, a contour plot of the time-averaged discord remarkably reproduces (eb) the structures of the classical stroboscopic map. **Vaibhav Madhok, Vibhu Gupta, Denis-Alexandre Trottier, and Shohini Ghose** also find surprisingly **opposite behavior** of two-qubit discord versus (e&eb) entanglement of the two qubits as measured by the concurrence. Results provide evidence of signatures of chaos in dynamically generated discord. http://dx.doi.org/10.1103/PhysRevE.91.032906©2015 American Physical Society **Signatures of chaos in the dynamics of quantum discord Vaibhav Madhok, Vibhu Gupta, Denis-Alexandre Trottier, and Shohini Ghose Phys. Rev. E 91, 032906 – Published 10 March 2015 STOP.** How do closed quantum many-body systems driven out of (e) equilibrium eventually achieve equilibration? And how do these systems thermalize, given that they comprise so many degrees of freedom? Progress in answering these—and related—questions has accelerated in recent years—a trend that can be partially attributed to success with experiments performing quantum simulations using ultracold atoms and trapped ions. **J. Eisert, M. Friesdorf & C. Gogolin** provide (eb) an overview of this progress, specifically in studies probing dynamical equilibration and (e&eb) thermalization of systems driven out of (e) equilibrium by quenches, ramps and periodic driving. In doing so, they also address (e&eb) topics such as the eigenstate thermalization hypothesis, typicality, transport, many-body localization and universality near phase transitions, as well as future prospects for quantum simulation. **Quantum many-body systems out of equilibrium J. Eisert, M. Friesdorf& C. Gogolin Nature Physics 11, 124–130 (2015) doi: 10.1038/nphys3215 Received 11 August 2014 Accepted 03 December 2014 published online 03 February 2015 STOP.** Quantum teleportation is (=) one of the most important protocols in quantum information. By exploiting the physical resource of entanglement, quantum teleportation serves as a key primitive in a variety of quantum information tasks and represents an important building block for quantum technologies, with a pivotal role in the continuing progress of quantum communication, quantum computing and quantum networks. **Stefano Pirandola, Jens Eisert, Christian Weedbrook, Akira Furusawa, and Samuel L. Braunstein** review the basic theoretical ideas behind quantum teleportation and its variant protocols. They focus on the main experiments, together with the technical advantages and disadvantages associated with the use of the various technologies, from photonic qubits and optical modes to atomic ensembles, trapped atoms, and solid-state systems. Analysing the current state-of-the-art, we finish by discussing open issues, challenges and potential future implementations. Cite as: arXiv: 1505.07831 [quant-ph] (or arXiv: 1505.07831v1 [quant-ph] for this version) **Advances in Quantum Teleportation Stefano Pirandola, Jens Eisert, Christian Weedbrook, Akira Furusawa, and Samuel L. Braunstein (Submitted on 28 May 2015) STOP. Toby Cubitt, David Elkouss, William Matthews, Maris Ozols, David Pérez-García & Sergii Strelchuk** show that this is not the case: for any number of uses, there are channels for which the coherent information is zero, but which nonetheless have capacity. Transmitting data reliably over noisy communication channels is one of the most important applications of information theory, and is well understood for channels modelled by classical physics. However, when quantum effects are involved, we do not know how to compute channel capacities. This is because the formula for the quantum capacity involves maximizing the coherent information over an unbounded number of channel uses. In fact, entanglement across channel uses can even increase the coherent information from zero to non-zero. **Toby Cubitt, David Elkouss, William Matthews, Maris Ozols, David Pérez-García & Sergii Strelchuk** study the number of channel uses necessary to detect positive coherent information. In all previous known examples, two channel uses already sufficed. It might be that only a finite number of channel uses are always sufficient. **Toby Cubitt, David Elkouss, William Matthews, Maris Ozols, David Pérez-García & Sergii Strelchuk** show that this is not the case: for any number of uses, there are channels for which the coherent information is zero, but which nonetheless have capacity. **Unbounded number of channel uses may be required to detect quantum capacity Toby Cubitt, David Elkouss, William Matthews, Maris Ozols, David Pérez-García & Sergii Strelchuk Nature Communications 6, Article number: 6739 doi:10.1038/ncomms7739 Published 31 March 2015 STOP.** Characterizing the behaviour of strongly coupled quantum systems out of equilibrium is a cardinal challenge for both theory and experiment. With diverse applications ranging from the dynamics of the quark–gluon plasma to transport in novel states of quantum matter, establishing universal results and organizing principles out of equilibrium is crucial. **M. J. Bhaseen, Benjamin Doyon, Andrew Lucas& Koenraad Schalm** present a universal description of energy transport between quantum critical heat baths in arbitrary dimension. Current-carrying non-equilibrium steady state (NESS) is a Lorentz-boosted thermal state. In the context of gauge/gravity duality this reveals an intimate correspondence between far-from-equilibrium transport and black hole uniqueness theorems. Authors provide analytical expressions for (e) the energy current and the generating function of (e) energy current fluctuations, together with (e&eb) predictions for experiment. **Energy flow in (eb) quantum critical systems far from (e) equilibrium M. J. Bhaseen, Benjamin Doyon, Andrew Lucas& Koenraad Schalm Nature Physics 11, 509–514 (2015) doi: 10.1038/nphys3320: Published online 04 May 2015 STOP.** Properties of systems near quantum critical points (QCPs) have been studied extensively. A QCP is (=) a point across which the symmetry of (e) the ground state of a quantum system changes in (eb) a fundamental way; such a point can be accessed by (e) changing some parameter, say λ, in the Hamiltonian governing the system. The change in the ground state across (e&eb) a QCP is mediated by (e) quantum fluctuations. Unlike conventional thermal critical points, thermal fluctuations do not (e) play a crucial role in such transitions. Similar to its thermal counterparts, the low-energy physics near (e&eb) a QCP is associated with a number of critical exponents which characterize the universality class of such a transition. Among these exponents, the dynamical critical exponent z provides (eb) the signature of the relative scaling of space and time at (eb) the transition and has (e) no counterpart in thermal phase transitions. The other exponent which is going to be important for (e) the purpose of this review is (=) the well-known correlation length exponent ν. These exponents are formally defined as follows. As we approach the critical point at λ=λc, the correlation length diverges as ξ∼|λ−λc|−ν, while (e) the gap between the ground state and first excited state vanishes as (e) ΔE∼ξ−z∼|λ−λc|zν. Exactly at the critical point λ=λc, the energy of the low-lying excitations vanishes at (eb) some wave number k 0 as ω∼|k−k0|z. The critical exponents are independent of (e) the details of the microscopic

Hamiltonian; they depend only on a few parameters such as the dimensionality of the system and the symmetry of the order parameter. These features render (eb) the low-energy equilibrium physics of a quantum system near a QCP truly universal. **Quantum Quenching, Annealing and Computation Lecture Notes in Physics Volume 802, 2010, pp 21-56 Date: 08 Mar 2010 Non-equilibrium Dynamics of Quantum Systems: Order Parameter Evolution, Defect Generation, and Qubit Transfer S. Mondal, D. Sen, K. Sengupta STOP Matthias Christandl, Nilanjana Datta, Artur Ekert, and Andrew J. Landahl** propose a class of qubit networks that admit (e) the perfect state transfer of (e) any quantum state in a fixed period of time. Unlike many other schemes for (e) quantum computation and communication, these networks do not (e) require qubit couplings to be switched on and off. When restricted to (e) N-qubit spin networks of identical qubit couplings, they show that (eb) 2log3N is the maximal perfect communication distance for (e) hypercube geometries. Moreover, if one allows fixed but different couplings between the qubits, then (eb) perfect state transfer can be achieved over (e&eb) arbitrarily long distances in a linear chain. **Perfect State Transfer in Quantum Spin Networks Matthias Christandl, Nilanjana Datta, Artur Ekert, and Andrew J. Landahl Phys. Rev. Lett. 92, 187902 – Published 4 May 2004 STOP.** As with classical information processing, a quantum information processor requires (e) bits (qubits) that can be independently addressed (e&eb) and read out, long-term memory elements to store (e) arbitrary quantum states1, 2, and the ability to transfer (e&eb) quantum information through (e&eb) a coherent communication bus accessible to (e) a large number of qubits3, 4. Superconducting qubits made with (e&eb) scalable microfabrication techniques are (=) a promising candidate for the realization of (e) a large-scale quantum information processor5, 6, 7, 8, and 9. (For references please see the paper). Although these systems have successfully passed tests of (e) coherent coupling for (e) up to four qubits10, 11, 12, 13, communication of individual quantum states between (e&eb) superconducting qubits via (e&eb) a quantum bus has not yet been realized. Here, authors perform an experiment demonstrating the ability to coherently transfer quantum states between (e&eb) two superconducting Josephson phase qubits through a quantum bus. This quantum bus is (=) a resonant cavity formed by an open-ended superconducting transmission line of length 7 mm. After preparing an initial quantum state with (e&eb) the first qubit, this quantum information is transferred and stored (e&eb) as a nonclassical photon state of (e) the resonant cavity, then retrieved later by (e) the second qubit connected to (e&eb) the opposite end of the cavity. Beyond simple state transfer, these results suggest (eb) that a high-quality-factor superconducting cavity could also function as (=) a useful short-term memory element. The basic architecture presented here can be expanded, offering (eb) the possibility for the coherent interaction of (e&eb) a large number of superconducting qubits. **Nature 449, 438-442 (27 September 2007) | doi:10.1038/nature06124; Received 18 April 2007; Accepted 25 July 2007 Coherent quantum state storage and transfer between two phase qubits via a resonant cavity Mika A. Sillanpää1, Jae I. Park1 & Raymond W. Simmonds1 STOP. Chui-Ping Yang, Shih-I Chu, and Siyuan** present a scheme to achieve maximally entangled states, controlled (e&eb) phase-shift gate, and SWAP gate for (e) two superconducting-quantum-interference-devices (SQUID) qubits, by (e) placing SQUIDs in a microwave cavity. **Chui-Ping Yang, Shih-I Chu, and Siyuan** also show how to transfer quantum information from one SQUID qubit to (e&eb) another. In this scheme, no transfer of quantum information between (e&eb) the SQUIDs and the cavity is required, the cavity field is (=) only virtually excited and thus the requirement on the quality factor of the cavity is (=) greatly relaxed. http://dx.doi.org/10.1103/PhysRevA.67.042311 **Possible realization of entanglement, logical gates, and quantum-information transfer with (e&eb) superconducting-quantum-interference-device qubits in cavity QED Chui-Ping Yang, Shih-I Chu, and Siyuan Han Phys. Rev. A 67, 042311 – Published 17 April 2003 STOP. L. Campos Venuti, C. Degli Esposti Boschi, and M. Roncaglia** explore the capability of spin-1/2 chains to act (e&eb) as quantum channels for (e) both teleportation and transfer of (e) qubits. Exploiting (e) the emergence of (e) long-distance entanglement in (eb) low-dimensional systems [Phys. Rev. Lett. 96, 247206 (2006)], here **L. Campos Venuti, C. Degli Esposti Boschi, and M. Roncaglia** show (eb) how to obtain high communication fidelities between (e&eb) distant parties. An investigation of protocols of teleportation and (e&eb) state transfer is presented, in (eb) the realistic situation where (e) temperature is included. Basing setup on (eb) antiferromagnetic rotationally invariant systems, both protocols are represented by (e) pure depolarizing channels. **L. Campos Venuti, C. Degli Esposti Boschi, and M. Roncaglia** propose a scheme where channel fidelity close to 1 can be achieved on (e&eb)

very long chains at moderately small temperature. **Qubit Teleportation and (e&eb) Transfer across Antiferromagnetic Spin Chains L. Campos Venuti, C. Degli Esposti Boschi, and M. Roncaglia Phys. Rev. Lett. 99, 060401 – Published 6 August 2007 STOP. David Petrosyan, Guy Bensky, Gershon Kurizki, Igor Mazets, Johannes Majer, and Jörg Schmiedmayer P** examine the possibility of coherent reversible information transfer between solid-state superconducting qubits and (e&eb) ensembles of ultracold atoms. Strong coupling between these systems is mediated by (e&eb) a microwave transmission line resonator that interacts near resonantly with (e&eb) the atoms via (e&eb) their optically excited Rydberg states. Solid-state qubits can then be used to (e) implement rapid quantum logic gates, while (e) collective metastable states of (e) the atoms can be employed for (e) long-term storage and (e&eb) optical readout of quantum information. **Reversible state transfer between superconducting qubits and (e&eb) atomic ensembles David Petrosyan, Guy Bensky, Gershon Kurizki, Igor Mazets, Johannes Majer, and Jörg Schmiedmayer Phys. Rev. A 79, 040304(R) – Published 14 April 2009 STOP.** Quantum computers have (e) the capability of out-performing their classical counterparts for (e) certain computational problems1. Several scalable quantum-computing architectures have been proposed. An attractive architecture is a large set of (e) physically independent qubits arranged in three spatial regions where (1) the initialized qubits are (=) stored in (eb) a register, (2) two qubits are brought together to (e) realize a gate and (3) the readout of (e) the qubits is carried out2, 3. For a neutral-atom-based architecture, a natural way to connect these regions is to use (e) optical tweezers to move qubits within (e&eb) the system. **Jérôme Beugnon, Charles Tuchendler, Harold Marion, Alpha Gaëtan, Yevhen Miroshnychenko, Yvan R. P. Sortais, Andrew M. Lance, Matthew P. A. Jones, Gaétan Messin, Antoine Browaeys & Philippe Grangier** demonstrate the coherent transport of (e) a qubit, encoded on (e&eb) an atom trapped in (eb) a submicrometre tweezer, over (e&eb) a distance typical of the separation between atoms in (eb) an array of optical traps4, 5, 6. Furthermore, authors transfer a qubit between (e&eb) two tweezers, and show that this manipulation also preserves (e&eb) the coherence of the qubit. **Nature Physics 3, 696 - 699 (2007) Published online: 12 August 2007 | doi: 10.1038/nphys698 Subject Categories: Atomic and molecular physics | Optical physics | Quantum physics | Information theory and (e&eb) computation Two-dimensional transport and transfer of (e) a single atomic qubit in (eb) optical tweezers Jérôme Beugnon, Charles Tuchendler, Harold Marion, Alpha Gaëtan, Yevhen Miroshnychenko, Yvan R. P. Sortais, Andrew M. Lance, Matthew P. A. Jones, Gaétan Messin, Antoine Browaeys & Philippe Grangier STOP.** In optically controlled quantum computers it may be favorable to address (e&eb) different qubits using (e) light with different frequencies, since (e) the optical diffraction does not then limit the distance between (e&eb) qubits. Using qubits that are close to each other enable (erb) qubit-qubit interactions and (e&eb) gate operations that are strong and fast in comparison to (e&eb) qubit-environment interactions and decoherence rates. However, as qubits are addressed in frequency space, great care has to be taken when designing the laser pulses, so that they perform (e&eb) the desired operation on (eb) one qubit, without (e) affecting other qubits. Complex hyperbolic secant pulses have theoretically been shown to be excellent for (e) such frequency-addressed quantum computing [I. Roos and K. Molmer, Phys. Rev. A 69, 022321 (2004)]—e.g., for use in quantum computers based on optical interactions in rare-earth-metal-ion-doped crystals. The optical transition lines of (e) the rare-earth-metal-ions are (=) inhomogeneously broadened and therefore the frequency of (e) the excitation pulses can be used to (e) selectively address qubit ions that are (=) spatially separated by (e&eb) a distance much less than a wavelength. , **Lars Rippe, Mattias Nilsson, Stefan Kröll, Robert Klieber, and Dieter Suter demonstrate experimentally** frequency-selective transfer of (e) qubit ions between (e&eb) qubit states using (e) complex hyperbolic secant pulses. Transfer efficiencies better than 90% were obtained. Using (e) the complex hyperbolic secant pulses it was also possible to create (eb) two groups of ions, absorbing (e) at specific frequencies, where (e) 85% of the ions at one of the frequencies were shifted out of (e) resonance with (e&eb) the field when (e) ions in the other frequency group were excited. This procedure of selecting (e&eb) interacting ions, called qubit distillation, was carried out (e&eb) in preparation for two-qubit gate operations in (eb) the rare-earth-metal-ion-doped crystals. The techniques for frequency-selective state-to-state transfer developed here may be also useful also for (e) other quantum optics and quantum information experiments in (eb) these long-coherence-time solid-state systems. **Experimental demonstration of efficient and selective population transfer and qubit distillation in a rare-earth-metal-ion-**

doped crystal Lars Rippe, Mattias Nilsson, Stefan Kröll, Robert Klieber, and Dieter Suter Phys. Rev. A 71, 062328 – Published 23 June 2005 STOP. Martin Leijnse and Karsten Flensberg propose a method to coherently transfer (e&eb) quantum information, and to create (eb) entanglement, between topological qubits and (e&eb) conventional spin qubits. Suggestion uses (e) gated control to transfer an electron (spin qubit) between (e&eb) a quantum dot and edge Majorana modes in (eb) adjacent topological superconductors. Because of the spin polarization of (e) the Majorana modes, the electron transfer translates spin superposition states into (e&eb) superposition states of the Majorana system, and vice versa. It is also shown how a topological superconductor can be used to (e) facilitate long-distance quantum information transfer (e&eb) and entanglement between (e&eb) spatially separated spin qubits. **Quantum Information Transfer between Topological and (e&eb) Spin Qubit Systems Martin Leijnse and Karsten Flensberg Phys. Rev. Lett. 107, 210502 – Published 18 November 2011 http://dx.doi.org/10.1103/PhysRevLett.107.210502 STOP. Gogyan** proposes a method that enables efficient conversion of the quantum information frequency between (e&eb) different regions of a spectrum of light based on (e) recently demonstrated (eb) strong parametric coupling between (e&eb) two narrow-band single-photon pulses propagating in (eb) a slow-light atomic medium [N. Sisakyan and Yu. Malakyan, Phys. Rev. A, 75, 063831 (2007)]. It is shown that an input qubit at (eb) telecom wavelength is transformed into (e&eb) another at a visible domain in (eb) a lossless and shape-conserving manner while (e) keeping the initial quantum coherence and (e&eb) entanglement. These transformations can be realized with quantum efficiency close to (e) its maximum value. http://dx.doi.org/10.1103/PhysRevA.81.024304 **Qubit transfer between (e&eb) photons at telecom and visible wavelengths in (eb) a slow-light atomic medium A. Gogyan Phys. Rev. A 81, 024304 – Published 25 February 2010 STOP. N. Cleland and M. R. Geller** propose a quantum computing architecture based on (e) the integration of nanomechanical resonators with (e&eb) Josephson-junction phase qubits. Resonators are GHz-frequency, dilatational disk resonators, which couple to (e&eb) the junctions through (e&eb) a piezoelectric interaction. System is analogous to (e) a collection of tunable few-level atoms (the Josephson junctions) coupled to (e&eb) one or more electromagnetic cavities (the resonators). Architecture combines desirable features of solid-state and optical approaches and may make (eb) quantum computing possible in a scalable, solid-state environment. **Superconducting Qubit Storage and Entanglement with (e&eb) Nanomechanical Resonators A. N. Cleland and M. R. Geller Phys. Rev. Lett 93, 070501 – Published 10 August 2004 STOP. D. N. Matsukevich, A. Kuzmich** report on the coherent quantum state transfer from (e) a two-level atomic system to a single photon Entanglement between (e&eb) a single photon (signal) and a two-component ensemble of (e) cold rubidium atoms is used to (e) project the quantum memory element (the atomic ensemble) onto (e&eb) any desired state by measuring (eb) the signal in a suitable basis. Atomic qubit is read out by (e) stimulating directional emission of (e) a single photon (idler) from (e) the (entangled) collective state of (e) the ensemble. Faithful atomic memory preparation and readout are verified by (e) the observed correlations between (e&eb) the signal and (e&eb) the idler photons. These results enable (eb) implementation of (e) distributed quantum networking. **Science 22 October 2004: Vol. 306 no. 5696 pp. 663-666 DOI: 10.1126/science.1103346 Quantum State Transfer Between Matter and (e&eb) Light D. N. Matsukevich, A. Kuzmich STOP. Giulia Gualdi, Vojtech Kostak, Irene Marzoli, and Paolo Tombesi** investigate the most general conditions under (e&eb) which a finite ferromagnetic long-range interacting (e&eb) spin chain achieves (eb) unitary fidelity and the shortest transfer time in transmitting (e&eb) an unknown input qubit. A deeper insight into system dynamics, allows (eb) to identify an ideal system involving (e&eb) sender and receiver only. However, this two-spin ideal chain is unpractical due to (e) the rapid decrease of (e) the coupling strength with (e&eb) the distance. Therefore authors propose an optimization scheme for (e) approaching the ideal behavior, while keeping the interaction strength still reasonably high. The procedure is (=) scalable with the size of the system and straightforward to implement. **Perfect state transfer in (eb) long-range interacting spin chains Giulia Gualdi, Vojtech Kostak, Irene Marzoli, and Paolo Tombesi Phys. Rev. A 78, 022325 – Published 18 August 2008 STOP. L Fedichkin, M Yanchenko and K. A Valiev** investigated the use of (e) quantum bits (qubits) - semiconductor quantum dots containing (e) one electron and each consisting of (e) two tunnel-connected parts - as basic elements of the quantum computer. Numerical solution of a Schrödinger equation taking account of (e) the Coulomb field of (e) adjacent electrons shows (eb) that in such structures (e&eb)the realization of (e) a full set of basic logic operations, which are necessary for (e) fulfillment of quantum computations, is (=) possible. Durations of one- and two-qubit operations versus (e&eb) qubit geometry are obtained. Decoherence rates due to (e) spontaneous emission of (e) phonons and acoustic phonons (both piezoelectric and deformation) are evaluated. Analysis of these rates shows (eb) the proposed qubit to be (eb) coherent enough to work for (e) an unlimited time. **L Fedichkin et al 2000 Nanotechnology 11 387 doi:10.1088/0957-4484/11/4/339 Coherent charge qubits based on GaAs quantum dots with a built-in barrier L Fedichkin, M Yanchenko and K A Valiev ©2015 American Physical Society STOP.** In recent years **S. Lorenzo, T. J. G. Apollaro, S. Paganelli, G. M. Palma, and F. Plastina P have** investigated the fidelity of (e) the quantum state transfer (QST) of two qubits by means of (e) an arbitrary spin-12 network, on (e&eb) a lattice of any dimensionality. Under the assumptions that the network Hamiltonian preserves (eb) the magnetization and that a fully polarized initial state is taken for (e) the lattice, they obtain (eb) a general formula for the average fidelity of (e) the two qubits QST, linking it to (e&eb) the one- and two-particle transfer amplitudes of (e) the spin excitations among the sites of (e&eb) the lattice. **S. Lorenzo, T. J. G. Apollaro, S. Paganelli, G. M. Palma, and F. Plastina P** apply this formalism to (e&eb) a 1D spin chain with (e&eb) XX-Heisenberg type nearest-neighbour interactions adopting (e&eb) a protocol that is a generalization of the single qubit one proposed in Paganelli et al. [Phys. Rev. A 87, 062309 (2013)]. They report that a high-quality two qubit QST can be achieved provided one can control (e&eb) the local fields at sites near the sender and receiver. Under such conditions, they obtain (eb) an almost perfect transfer in a time that scales (e&eb) either linearly or, depending on the spin number, quadratically with (e&eb) the length of the chain. **Transfer of arbitrary two-qubit states via (e&eb) a spin chain S. Lorenzo, T. J. G. Apollaro, S. Paganelli, G. M. Palma, and F. Plastina Phys. Rev. A 91, 042321 – Published 16 April 2015 http://dx.doi.org/10.1103/PhysRevA.91.042321 ©2015 American Physical Society STOP.** Combining techniques of cavity quantum electrodynamics (e&eb) quantum measurement, and (e&eb) quantum feedback, Norbert **Kalb, Andreas Reiserer, Stephan Ritter, and Gerhard Rempe** realize the heralded transfer of (e) a polarization qubit from a photon onto (e&eb) a single atom with 39% efficiency and 86% fidelity. The reverse process, namely, qubit transfer from (e) the atom onto a given photon, is demonstrated with 88% fidelity and an estimated efficiency of up to 69%. In contrast to previous work based on (e) two-photon interference, scheme is (=) robust against photon arrival-time jitter and achieves (eb) much higher efficiencies. Thus, it constitutes (eb) a key step toward the implementation of (e) a long-distance quantum network. Journal reference: Phys. Rev. Lett. 114, 220501 (2015) DOI:10.1103/PhysRevLett.114.**220501 Cite as:arXiv:1503.06709 [quant-ph] (or arXiv:1503.06709v2** [quant-ph] for this version) **Heralded Storage of a Photonic Quantum Bit in a Single Atom Norbert Kalb, Andreas Reiserer, Stephan Ritter, Gerhard Rempe 2 Jun 2015 STOP.** Current high-throughput DNA sequencing technologies enable (eb) acquisition of billions of data points through (e&eb) which myriad biological processes can be interrogated, including (e) genetic variation (e&eb) chromatin structure (e&eb) gene expression patterns, small RNAs and protein–DNA interactions. **Mark A Urich, Joseph R Nery, Ryan Lister, Robert J Schmitz & Joseph R Ecker** describe the MethylC-sequencing (MethylC-seq) library preparation method, a 2-d protocol that enables (eb) the genome-wide identification of cytosine DNA methylation states at (eb) single-base resolution. The technique involves (e&eb) fragmentation of genomic DNA followed by (e) adapter ligation, bisulfite conversion and (e&eb) limited amplification using (e) adapter-specific PCR primers in preparation for (e) sequencing. To date, this protocol has been successfully applied to (e&eb) genomic DNA isolated from (e) primary cell culture, (e&eb) sorted cells and (e&eb) fresh tissue from over (e&eb) a thousand plant and animal samples. **NATURE PROTOCOLS | PROTOCOL MethylC-seq library preparation for base-resolution whole-genome bisulfite sequencing Mark A Urich, Joseph R Nery, Ryan Lister, Robert J Schmitz & Joseph R Ecker Nature Protocols 10, 475–483 (2015) doi:10.1038/nprot.2014.114 Published online 18 February 2015 STOP.** Starting from a product initial state, equal-time correlations in (eb) nonrelativistic quantum lattice models propagate (e&eb) within (eb) a lightcone-like causal region. The presence of entanglement in (eb) the initial state can modify (e&eb) this behavior, enhancing and accelerating (eb, eb+) the growth of correlations. **Michael Kastner** gives a quantitative description, in the form of Lieb-Robinson-type bounds on (e&eb) equal-time correlation functions, of (e) the interplay of dynamics vs.(e&eb) initial entanglement in quantum lattice models out of (e) equilibrium. **Michael Kastner** tests the bounds against (e&eb) model calculations, and also Cite as: arXiv:

1507.00529 [quant-ph] (or arXiv: 1507.00529v1 [quant-ph] for this version) **Entanglement-enhanced spreading of (e) correlations Michael Kastner (Submitted on 2 Jul 2015) STOP.** A scheme based on (e) coherent tunneling by (e) adiabatic passage (CTAP) of exchange-only spin qubit quantum states in a linearly arranged double quantum dot chain is demonstrated. Logical states for the qubit are defined by adopting the spin state of three electrons confined in a double quantum dot. The possibility to obtain gate operations entirely with electrical manipulations makes this qubit a valuable architecture in the field of quantum computing for the implementation of quantum algorithms. Effect of the external control parameters as well as the effect of the dephasing on the coherent tunneling in the chain is studied. During adiabatic transport, within a constant energy degenerate eigenspace, the states in the double quantum dots internal to the chain are not populated, while transient populations of the mixed states in the external ones are predicted. **Coherent tunneling by adiabatic passage of an exchange-only spin qubit in a double quantum dot chain E. Ferraro, M. De Michielis, M. Fanciulli, and E. Prati Phys. Rev. B 91, 075435 – Published 26 February 2015 STOP. Following system is discussed: Quasinormal Modes Of Black Holes, Quasinormal Spectrum And The Black Hole Membrane, Zero Sound From Holography, Relativistic Viscous Hydrodynamics, Conformal Invariance, And Holography, Supersymmetric Yang-Mills Plasma, Dense Chern-Simons Matter With Fermions, Hydrodynamics On The Lowest Landau Level, Curved Non-Relativistic Spacetimes And Newtonian Gravitation, Spacetime Symmetries Of The Quantum Hall Effect, Pseudo-Supersymmetric Quantum Mechanics, Holographic Description Of A Quantum Black Hole On A Computer, Matrix Perturbation Theory For M-Theory, Supersymmetric Yang–Mills Quantum Mechanics, Matrix Quantum Mechanics As A Fundamental Theory**

Key words: Quasinormal Modes, Black Holes, Quasinormal Spectrum, Black Hole Membrane, Zero Sound, Holography, Relativistic Viscous Hydrodynamics, Conformal Invariance, Holography, Supersymmetric Yang-Mills Plasma, Dense Chern-Simons Matter, Fermions, Hydrodynamics, Lowest Landau Level, Curved Non-Relativistic Spacetimes, Newtonian Gravitation, Spacetime Symmetries, Quantum Hall Effect, Pseudo-Supersymmetric Quantum Mechanics, Holographic Description Of A Quantum Black Hole , Matrix Perturbation Theory, M-Theory, Supersymmetric Yang–Mills Quantum Mechanics, Matrix Quantum Mechanics

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PREFACE

Note: Some of the following concepts are modelled; some are not. For those which are not modelled kindly see one of the papers in the series. This note has the axiomatic predication to give a holistic view of the study. Here we talk of the characterstics of systems which satisfy the condition of cosmological constant or any other for that matter or variable or axiomatic predication. . There are lots of zeroes corresponding and concomitant to the second law of black holes. Infact as many as that of extant and existential blackholes exist. At the outset, it is to be stated that there are hadrons in every system. Supersymmetry between forces and matter, with both open and closed strings; no tachyon; group symmetry is SO (32) and its axiomatic predications, predicational anteriorities, character constitution shall be extant and existential in very many systems, and the characterstics are taken in to consideration in the classification scheme. Many systems have such fundamental instabilities like that of quantum gravity and characterstics of those systems form the citadel and fulcrum, bulwark and manor, mainstay and reinforcement, alcazar and chateau theory has a fundamental instability on which the classification schémas are valid. There are lots of systems which follow the axioms of string theory. It is the characterstics of this system which are taken in to consideration in the classification scheme. "All institutionalization involves common moral as well as other values. Collectivity obligations are, therefore, an aspect of every institutionalized role. But in certain contexts of orientation-choice, these obligations may be latent ...." (Parsons, 1951, p. 99). There are various systems that have the same bastion, support system, stylobate and sentinel as that of the Deleuzean terms and predications and phenomenological methodologies systemized. Look at this beautiful passage whose stability analysis would be eye opener. To "deconstruct" is not the same as to destroy. Deconstruction attempts to undo logical contradictions, to overturn rigid conceptual oppositions while releasing new concepts and meanings that could not be included in the old system. At the heart of Western metaphysics, for example, Derrida finds the opposition between "speech" and "writing." This binary logic functions in an illicit way to establish speech as the means of giving "presence" to the world, while writing is deemed derivative and inferior In Derrida's sense of "grammatology," however, all production of meaning is writing and subject to the infinite play of signification. By taking away the transcendental signified and advancing the concept of "differance" (language organized around difference and deferred, or mediated, understandings), Derrida, like Nietzsche, wants to leave us without transcendental illusions, metaphysical unities, and foundations that constrain thought and creativity. **THE POSTMODERN TURN IN PHILOSOPHY: THEORETICAL PROVOCATIONS AND NORMATIVE DEFICITS by Steven Best and Douglas Kelner http://www.gseis.ucla.edu/faculty/kellner/kellner.html** Each and every system has electrons, neutrons and protons and for that matter quarks. There shall be strong nuclear force and weak nuclear force. There are many systems that satisfy the criterion specified by the equation, principle or statement in question. Characterstics of the investigating systems form the bastion for the classification scheme and doxa thereof. Systemic differentiation is conducted. Despite gravity being constant, there exists gravity between two objects, and this could be taken as a system. Depending upon some parametric representationalities, functionalities, advantageousness, appropriateness, benefit, facilitation, fittingness, helpfulness, instrumentality, merit, practicality, serviceability, suitability, and usefulness, utility, these systems could be classified in to various categories. In respect of an equation, there shall be many systems that satisfy the given equation. Equations themselves could be by the utilization of the model solved term by term as has been exemplified and illustrated many time in the previous papers. There is lot of systems that could be brought in to the orbit of and gamut of the theory in question which the investigatable systems satisfy the axiomatic predications and postulation alcovishness of the systems in question. Towards the end of classificational consummation, consolidation, corporation and concatenation we take the characterstics of the systems, the predicational interiorities, ontological consonance and primordial exactitude, accolytish representations, functional topology, apocryphal aneurism and atrophied asseveration, event at contracted points, and other parameters as the bastion and stylobate of the stratification purposes. Such totalistic entities would have easy paradigm of relational content, differentiated system of expressly oriented actions with primary focus and locus of homologues receptiveness and differentially instrumental activity, variable universalism and particularism, imperative compatibilities and structural variabilities, interactional dynamical orientation, institutionalization and internalisation of pattern variables common attitudinal orientation of constituionalisation of internalized dispositions, and a qualitative gradient of structural differentiation and ascribed particularistic solidarity abstraction or interactional dynamics, internal differentiation, structural morphology, formal characterization, concept formulation, phenomenological methodologies, constituent structure, transformational minimal condition, paradigmatic feasibilities, programmatic plausibilities, comparative variability, normative aspect of expectational prediction, projection and prognostication as consideration of the investigatory systems. Any scale can be used that is convenient to the classification scheme. It is important to note that the scheme of classification and the stratification doxa must not be adversely antagonistic, inexorably irreconcilable, antithetically antipodal, diametrically opposed, repugnantly retrogressive, inimically inverse, violatively unsimilar, diversely dissimilar, antipathetically anti thetical, conflictingly combative, obstructively pugnacious, inimically obstructive, repellently restrictive, disputatiously gainsaying or conformingly pugnacious to the axiomatic predications and postulation alcovishness of the theory in question or the equation representative or constitutive thereof. Sole intention, main objective and primary aim is twofold. One is towards the end of circumvention of the extra equation and the concomitant and corresponding variable therein. Second is avoidance of clustered congest, swarmed huddle, mustered pack, sardine squash, and swamp throng in the scheme of classification. Only thing that is sought out is the consonance in the entire diaspora and body fabric of the systems under study. This statement is true and holds unmistakably true for all the papers and I sincerely entreat readers to remember the statement and read the paper against this background. When we write A+B we mean by that B is being added to A or vice versa. It is like adding milk to water and water to milk. There may or may not be a time gap. As said earlier there may be many systems that satisfy the conditions of the equations and those systems that are investigatory or investigatable are taken in to consideration based on their characterstics in the classification doxa. When there are more than two entities, we can take logarithm and find the value of that factor to be taken with anti log to obtain prediction and projected values of the model. In case of A-B, we are removing B from A and that means B is eating up A. These factors are taken in to consideration in the application of the model to equations. Log (ab) and Log (a+b) is well defined. Model stands out as universal testament and template for application to each sentence and equation what with the quantification process done and the correlations well defined. In the eventuality of non existence of any connection at some phase, the model would have the accentuation and attrition coefficients and detritions coefficients as zero rendering the equations of concatenation simpler. Projection formula which incorporates in its diaspora the initial values provide autheticative determination, unimpeachable validation, incontrovertible establishment , apodictic evidence, reliable roll out, unfailing cinquecento quattrocento trecento, incontrovertible indication of the final finale, notwithstanding appellation, appellative, brand, cognomen, compellation, designation, flag, handle, identification, label, moniker, nomen, slot, style, surname, tab, tag, term, title designation, appellation, appellative, class, classification, denomination, description, epithet, of the classification scepter, scenario, scimitar, schottische. There is pure and impure consciousness in every one. Gratification producing and deprivation producing one's can be easily classified from individual general ledgers. Similar analogy holds for collective general ledger and cosmic general ledger or nature's general ledger. It is also to be noted that while dealing with equations towards the end of consummation of the measure, it is necessary that the two variables are to be classified in to three sections and each one would have the adventitious and decidedly stated relationship whereby the fundamental equations are drawn up and the analysis made. All the parametric representationalities, conditionalities, orientationalities remain unequivocal as stated in the variables stated in to consideration section and are different from module to module. In essence the paper is to be read as holistic one with the sole intention, primary objective and raison d' etre to build a TOE. Towards the end of circumvention of typing hundreds of superscripts and subscripts which would be a sardine squash and the concomitant operational difficulties, model is presented in piece meal of nine modules. Logarithms are to be taken in respect of those which incorporate more than one variable in bra-ket. Values of log (ab) and log (a+b) are readily available. Anti logarithm shall be taken at the end to predict, project, prognosticate the value of the variable. This is true for tensors, vectors and other variables too. Affirmational assertion, and explanation justification, statement of vindication, annotational commentary, and explicational glossary for each and every system changes and physical interpretation of results is one thing that is to be with earnest endeavour and feverish and febrile expediency. Editions never ever mean the same and identicality of parameters and this has been explicitly and unmistakably stated in the model apriori itself. Akin and analogous, cognate and concurrent, correspondent and congruent, comparable and complementary, synonymous and duple, tantamount and agnate, commensurate and correlative representation is only to highlight the importance and subterfuge the replication of work. It is my fervent solicitation to kindly bear with me for any lapses, notwithstanding the orchestrated efforts for a paper without any minor errors. Postulation predication, conclusive presumption, differential presuppositions, underscored decidedly axiomatic statement of the statement, equation form the bye word or the watch word in the aggrandizement-amplification, caricature and crock, understatement- unembellishment, elocution-emphasis, enunciation-inflection, announcement-argument, articulation, assertion, asseveration, choice of words, commentary and communication, declaration and definition, delivery-diction, elucidation-emphasis, enunciation-execution, explanation, exposition-formulation, idiom, interpretation and intonation tone and tenor of stratification. Now, how do find the reaction of systems to these singularities. You do the same thing a boss does for you. "Problematize" the events and see how you behave. I will resort to "pressure tactics". "intimidation of deriding report", or "cut in the increment" to make you undergo trials, travails and tribulations. I am happy to see if you improve your work; but may or may not be sad if you succumb to it and hang yourself! We do the same thing with systems. systems show conducive response, felicitous reciprocation or behave erratically with inner roil, eponymous radicality without and with blitzy conviction say like a solipsist nature of bellicose and blustering particles, or for that matter coruscation, trepidiational motion in fluid flows, or seemingly perfidious incendiaries in gormandizing fellow elementary particles, abnormal ebullitions, surcharges calumniations and unwarranted(you think so but the system idoes not!) unrighteous fulminations. Amount of emotion or affect that is appropriate or expected in an given form of interaction. Particular individuals and diffuse obligations (see c and d) are associated with affectivity, whereas contacts with many individuals (universalistic) in a bureaucracy may be devoid of emotion and characterized by affective neutrality. Affective neutrality may refer to self discipline and the deferment of gratification (eg Weber's spirit of capitalism). In contrast, affectivity may be associated with expressing emotions. Adams and Sydie also refer to affective neutrality being associated with ego control (p. 15). (Parsons: Wikipedia). So the point that is made here is "like we problematize the "events" to understand the human behaviour we have to "problematize" the events of systems to understand their behaviour. This statement is made in connection to the fact that there shall be creation or destruction of particles or complete obliteration of the system (blackhole evaporation) or obfuscation of results. Some systems are like "inside traders" they will not put signature atoll! How do you find they did it! Anyway, there are possibilities of a CIA finding out as they recently did! So we can do the same thing witn systems to. This is accentuation, corroboration, fortification, .fomentatory note to explain the various coefficients we have used in the model as also the dissipations called door. In the bank example we have clarified that various systems are individually conservative, and their conservativeness extends holisticallytoo.that one law is universal does not mean there is complete adjudication of nonexistence of totality or global or holistic figure. Total always exists and "individual" systems always exists, if we donot bring Kant in to picture! For the time being let us not! Equations would become more ensorcelled and frenzied........ philosophy merges with ontology; ontology merges with univocity of being; analogy has always a theological vision; not a philosophical vision; one becomes adapted to the forms of god; self and world; the univocity of being does not mean that there is one and the same being; on the contrary, beings are multiple and different they are always produced by disjunctive synthesis; and they themselves are disintegrated and disjoint and divergent; membra disjuncta.the univocity of being signifies that that being is a voice that is said and it is said in one and the same "consciousness". In consciousness research, two rival sets of theories can be recognized: (A) Scientific material interpretations of consciousness are based on axioms that view consciousness in the context of highly advanced intentional processing of information in which subject-object relations evolve, and (B) humanistic interpretations of consciousness are based on axioms that view consciousness in the context of, say, "centered pulsations" that enable a conscious agent to act from his or her center of awareness. In this paper I will argue for the selection of axioms that favor humanistic interpretations of consciousness. The Pursuit of Autonomy Interdisciplinary Observations to Human Consciousness: Wautischer, Helmut (1993) the Pursuit of Autonomy. Interdisciplinary Observations to Human Consciousness: Social Neuroscience Bulletin, 6 (4). pp. 52-56.Everything about which consciousness is spoken about being is the same for everything for which it is said like gravity; it occurs therefore as an unique event for everything; for everything for which it happens; eventum tantum; it is the ultimate form for all of the forms; and all these forms are disjointed; it brings about resonance and ramification of its disjunction; the univocity of being merges with the positive use of the disjunctive synthesis, and this is the highest affirmation of its univocity like gravity; it is the eternal resurrection or a return itself, the affirmation of all chance in a single moment, the unique cast for all throws; a simple rejoinder for Einstein's god does not play dice; one being, one consciousness, for all forms and all times. a single instance for all that exists, a single phantom for all the living; a single voice for very hum of voices; or a single silence for all the silences; a single vacuum for all the vacuums; consciousness should not be said without occurring; if consciousness is one unique event in which all the events communicate with each other; univocity refers both to what occurs to what it is said. This is attributable to all states of bodies and states of affairs and the expressible of every proposition. So univocity of consciousness means the identity of the noematic attribute and that which is expressed linguistically and sense fully. Univocity means that it does not allow consciousness to be subsisting in a quasi state and but expresses in all pervading reality; **CONSCIOUSNESS AND ITS UNIQUENESS June 12, 2012 at 8:40pm (See Deleuze Logic of sense, Wikipedia and Stanford encyclopedia for more details)** Atrocious contrivance and device, gratificational primogeniture, calamitous dodge and expedient, depraved, destructive, disastrous, execrable gambit and gimmick, great solace and succor, iniquitous, injurious, loathsome, low, maleficent, malevolent machination and maneuver, promethaleon of candor, frankness, honesty, honor, ingenuousness, innocence, openness, reality, sincerity, truthfulness, spiteful, stinking, ugly, unpleasant, unpropitious play and ploy, progenitor of jurisprudence and circumspection, racket and ruse, savvy, scam, stratagem, subterfuge, tactic and wile, forthrightness, honesty, truthfulness embodied and personified is the structural predisposition and dispensation of the complex. Nobody need have to take the Brahman-Anti Brahman agency to be a recalcitrant, repugnant, and refractory proposition. God gives and also takes away. That is the point made. And of course lesser gods, and God doth follow them and they follow God. That is why they are lesser gods. And wield the power on lesser mortals like us. When we mean gratification and deprivation we mean celestial Brahman Anti Brahman and Terrestial Brahman and Anti Brahman agencies producing such happiness or sadness by any means such as (blending- amalgamation, adulterant-adulteration, amalgam-amalgamation, blend- combination, composite- compound, debasement-denaturant, fusion-hybrid, intermixture-reduction, amalgam- mixture, composite- compound, fusion-mishmash, aggregate- alloy, amalgamation-blend, commixture-composite, composition-compost, conglomerate-fusion, goulash-medley, mishmash-stew, blend-coalition, commixture-compound, federation-heating, integration-junction, melting-merger, synthesis-unification, assortment- combination, adulteration-alloy, assimilation-association, batter-blend, brewed combine, composite compound, concoction confection, conglomeration cross of money, orientation(dis), penury creation, murder, mayhem plunder, pillage, apocalypse, Armageddon in various forms and permutation and combination of Manichaean artifice, agathokakological malevolence, agley chicane fourberie, fraud, furtiveness, gambit, awry and bad ,flagitious mechanizations, cacodemonic gambit, hanky-panky, intrigue, machination, deprecatory and diabolic underhandedness and wiles, energumenical skullduggery, goetic chicanery, lenocinant stratagem, malefic and maleficent strategy, malominous sell, sellout, sham subterfuge, peccable, humbug, imposture, misrepresentation peccant fraud, fraudulence, hoax, qued , scelerate pretense, ruse, sell, sellout, sham stratagems' of maladroit manouevures , sinistral ,tortious and venal sophistry, contingency enterprise, endangerment emprise, jeopardizing adventure, jejune jeremiad, avoidable inertia, latent passiveness: with each action accounted and showing balance in the nature's general ledger as also actionlessness:e). All these are recorded in Nature's general ledger. Neuron DNA encapsulates all the actions passions, actions, interactions, transactions or the lack of it at various levels of individual, collective and cosmic levels. In celestial Brahman Anti Brahman ledger there is cessation of dualities. One more point to be made is if 5=3+2, then we can say 5 gormandizes 3 or 5 gobbles up 2. Quintessentially such a statement arises out of the difference of LHS and RHS term wise. It must be remembered despite all theoretical abstractions and generalizations be it proton mass or Higgs Boson, or topology of a space, it is notwithstanding the fundamentality of nature is just a number. Just everything in Physics and mathematics is just a number. Let us assume I buy rice in Bangalore (District) worth 5k.g. I can always divide 5k.g.s of rice in categories of Bangalore (South), Bangalore (west), Bangalore (East) and Bangalore (South). On similar basis, there are billions of neutrons, protons and concomitant interactions which would satisfy the given numerical value. Example of gravity above makes things clear. Everything atleast is a function of time and someplace or some other coordinates, subordinates or superordinates. Mass of proton is 2.47 does not mean total mass of all protons is 2.47. It is this argument that is used in the classification scheme. By the very nature, self the unmonitoring but the witness consciousness agency identifies itself with something, be it a profession, an actor on the screen, when it does not have a identity. Such examples are legion, a Charlie Chaplin in "The Kid" or Raj kapoor in "Jagte Raho". These are people who just wanted to live and living without being put under surveillance every moment is the greatest part of their life. This is "Absolute Subjectivity" of Shiva. Such a state is always craving for identification for in pure consciousness all identities are lost. It is this "identitylessness" or having very minimal identity is what pervades most in India and this is due to expansion of individual consciousness. When that happens, be it education, or wealth, the "identity' becomes so well entrenched, they become the exact opposite of "pure consciousness"," impure consciousness" (Shakti). This is a state of "Absolute or relativistic objectivity". There was this case of a lady who went to such an extent of planning, she was sure that whatever she does must work out. When it did not, she lapsed in to "identity crisis". Such thing as this might happen in well developed countries where the competition is extremal and to be achieved at any cost. Realisation that one is not the doer but the witness consciousness is just like watching a movie in which one has acted. It is in this sense "advaita", "non duality' seems to be of cardinal and preeminent importance for the analytical treat ment of "identity' and "identity lessness", both happen in space time. "Multiverses" in this sense is also like a different film of an actor released at different theaters and it is in this sense we state that that every object in space time is a multiverse. You must have totally immersed in doing a "string theory" problem or watching a "film", oblivious of surroundings. Essentially creation (space time) also is what is happening in mind and honed in to you billion times. Identification of anything with a designation or signification is one that leads to association within spacetime, which would only have pathological consequences and detrimental ramification as stated above or positive implications of "happiness" because of the identity itself. Search or 'show" has to go on! It gives a sense of consummation. a watching pot never boils; donot go to check nature; you are disturbing it; it will never show its true colours bhakti and Virakthi, gratification and deprivation, raga and dwesha is essential to live in space. It is the quantum interest thereof that produces energy to live .gratification and deprivation which form the bastion, pillar, post and stylobate and sentinel of all human actions depends on tams, rajas, and sattva of individual or insentient object. Verily tamas, rajas and satva are the characterstics of space itself, nay the behavioural pattern and attitudinal orientation. There are peaceful places like

Vienna or Sringeri and there are violent places like others. Space is warped and woofed by the Akshara, the quantum information of primordial syllable Om. cosmic general ledger is the one vibration of which is brahman; quantum information possessions thereof form the sentinel of all transactions (Gargi to Yajnavalkya: my interpretation)adhocism, nonseqientiality of events, anti sequentiality of events, simultaneity of phenomenon, concurrent happenings , improbability of phenomenon happening itself are characterstics of brahman-anti brahman (Terrestial and celestial) are the cause of non predictability of happenings like in black hole, or in the areas of operation of brahman-anti brahman (Terrestial and celestial). brahman AntiBrahman actions, interactions, decisions, circumspection, adhocism, satisfies sensitive to initial conditions; topologically mixing; dense periodic orbits, the axiomatic predications and postulation alcovishness of chaos theory. Like gravity is a characteristic of space, so is tamas, rajas, sattva, with spaces knotted together by quantum information (for models see below) .accidents are preplanned actions of Terrestial and celestial Brahman AntiBrahman. All actions are perpetrated by them, be it train on fire or death. Belief systems play an important role in the determination of tamas, rajas, and satva state of human beings. There is neither cause nor effect. All actions are performed by Terrestial and celestial Brahman anti Brahman and it is off the record. psychic energy is negative equivalent to –mc^2, so that second law of thermodynamics is satisfied on a holistic basis vis-à-vis material energy ParaBrahaman is infinite individual, collective and cosmic consciousnesses are infinite (concomitant general ledgers) for they are in the evolution mode with respect to each other in that order. Later emanates from the former as transactions emanate from the conservative state of assets and liabilities. Is not zero true for infinite conservative systems inside space and time? zero is the only consummation, consolidation and conservation. if fifty out of seventy members come out of the room at whatever time you come out, talk about the grand limbo of oblivion and hibernation of lifeless world you are going to and if you are not a celebrity, then it is not coincidence, it is coordination. Nature is playing the same trick on you. That a generalised law is there and you can measure does not make things less good albeit recalcitrant, refractory and rogue particles occur time and again, by and large. Entering in to all living beings through his constant part on the new moon night, he is born therefrom next morning. Absolute ParaBrahaman (zero) projects himself again and again on the screen of individual consciousness which appears of depairing despondent world. Some where the balancing act is done on karma. cosmic general ledger reflects upon itself to keep all transactional ties conservative (Brihadarnkayaka Upanishad: 1.5 14) for models see next paper through its divine power (i interpret man creates god; it is attribution and ascription of various Shaktis would the formation of god takes place like space and time) the self assumes (eb) the form of a deity man can contemplate and venerate, even though siva, the pure subject, can never in fact be an object of meditation (adhyeya). Until we realise our true identity with Sankara, he is worshipped and conceived to be a reality alien to ourselves. While we are in the realm of creation, he too is a creation or mode or appearing of the absolute, manifest to us in meditation, through his freedom as an eternal, omniscient being. There is no gulf between the created and the uncreated creator: nothing in reality, although an object of knowledge, ceases to be Siva: this is the reason why meditation [on this or that aspect] of reality bestows its fruit. The world of the senses and mind appears to the well awakened (suprabuddha) as a theophany, an eternal revealing of god in his creation. The doctrine of vibration declares that "there is no state in word, meaning or thought, either at the beginning, middle or end, which is not Siva." 59 to utter any word is, in reality, to intone a sacred formula.every act is a part of Siva's eternal cosmic liturgy, every movement of the body a ritual gesture (mudras), and every thought, god's thought. By what path are you not attainable? What words do not speak of you? in which meditation are you not an object of contemplation? What indeed are you not, o lord? 61 spandashakti, which accounts for the appearing of all things, is also the means by which deity in its many varied forms appears to man. Ksemaraja concludes: the ultimate object of worship of any theistic school differs not from the Spanda principle. The diversity of meditation is due solely to the absolute freedom of Spanda. 62 Sankara is not only the supreme object of devotion; as the static polarity of the absolute, he is the inner reality which holds together its Siva and Sakti outer manifestations. Phenomena are patterns of cognitions projected onto the surface of self-luminous siva-consciousness. There they become apparent, directly revealed to consciousness according to their manifest form. Siva is accordingly symbolized as the ground or surface of awareness, smooth and even like a screen (samabhittitalopama). 64 inscribed on this screen (kutfya) are the countless manifest forms which appear within it rendering it as diverse and beautiful as a fossil ammonite (falagrama). 65 Siva is the sacred ground upon which the cosmic mandalas are drawn, the absolute surface of inscription which bears the mark (cihna) of the universe. Abhinava writes: the variety of this world can only be manifest if the highest lord, who is essentially the pure light of consciousness, exists; just as a surface is necessary for a picture. if external objects were perceived in isolation then, because 'blue' and 'yellow', etc., are self-confined and the perceptions [we have of them] refer to their objects alone and so are insentient, mute and dumb in relation to one another . . . how would it be possible to be aware that an object is variegated? but just as depths and elevations can be represented by lines on a smooth wall, and we perceive [a female figure and think], similarly it is possible to be aware of differences in the variegated (contents of experience) only if all the diverse perceptions are connected together on the one wall of the universal light of consciousness. 66 Siva is the perfect artist who, without need of canvas or brush, paints the world pictures. the instant he imagines it, it appears spontaneously, perfect in every respect. The colours he uses are the varying shades and gradations of his own Spanda energy and the medium his own consciousness. Intractable disaffect, Mutinous obdurate, Rebellious recalcitrant, Seditious refractory, Insubordinate insurgent, antagonistically antipodean, discrepant incompatible, Contumacious coadjutant, Conflicting converse, Unyielding obdurate, the antagonistic and anachronistic dispositional ties of Anti Brahman are in fact the sine qua non of Brahman only (See Vishwaroopa of Mahavishnu, which contains the polarised positives on RHS and negatives on LHS). The universe is coloured with the dye of its own nature (svabhava) by the power of Siva's consciousness (a//). Rajanaka rama says: homage to him who paints the picture of the three worlds, thereby displaying in full evidence his amazing genius {pratibha)\ to Sambhu who is beautiful with the hundreds of appearances laid out by the brush of his own unique, subtle and pure energy. 68 analogously, at the microcosmic level, all the cognitions and emotions, etc., which make up the individual personality form the outward flow of essentially introverted consciousness. They are specific pulsations (vise$aspanda) or aspects of the universal pulsation (samanyaspanda) of pure t consciousness. at the lower level, within the domain of maya, they represent the play in the fettered soul of the three primary qualities (gunas) or feeling-tones' which permeate to varying degrees his daily experience. These are: 1) sattva — the quality of goodness and luminosity which accompanies blissful experience both aesthetic and spiritual. 2) Rajas — the passion or agitation which oscillates between the extremes of 'light' and 'darkness' and characterises inherently painful experiences. 3) Tamas — the torpor and delusion which accompany states of inertia and ignorance. 69 the liberated soul recognises that these three are the natural and uncreated powers of pure consciousness. for him they are manifest respectively as: 1) Sankara 's power of knowledge (jnana) — the light of consciousness (prakasa); 2) the power of action (kriya) — the reflective awareness of consciousness (vimarsa)\ 3) the power of maya — which does not mean here the world of diversity, but the initial subtle distinction which appears between subject and object in pure consciousness. 70(doctrine of vibration: mark S.G. Dyczkowski) .to "deconstruct" is not the same as to destroy. Deconstruction attempts to undo logical contradictions, to overturn rigid conceptual oppositions while releasing new concepts and meanings that could not be included in the old system. at the heart of western metaphysics, for example, derrida finds the opposition between "speech" and "writing." this binary logic functions in an illicit way to establish speech as the means of giving "presence" to the world, while writing is deemed derivative and inferior in derrida's sense of "grammatology," however, all production of meaning is writing and subject to the infinite play of signification. By taking away the transcendental signified and advancing the concept of "differance" (language organized around difference and deferred, or mediated, understandings), derrida, like Nietzsche, wants to leave us without transcendental illusions, metaphysical unities, and foundations that constrain thought and creativity. The postmodern turn in philosophy: theoretical provocations and normative deficits by Steven best and Douglas Kelner http://www.gseis.ucla.edu/faculty/kellner/kellner.html. you cannot see beyond consciousness for that is the limit of your storage of information or the basis for understanding further information. Turiya is empty bucket; it is from which prajna the measure of arises; turiya measures the number of quantum information stores in other three states of waking, dreams, and dreamless deep sleep (Manduka Upanishad; my interpretation for models next paper).let there be path where angels tread: it is a force never born never dies the brahman an anti brahman verily there are parallel universes in (eb) in the ambit of space and time; the society of sinners and the sinned with the grammar of evil; parallel universes contain(e) multiverses in them; all physics, philosophy, break down(e) in these universes;

astronomical gratification ,deprivation, glorification, mortification, projections, axes, dimensions, rotations, foldings, concurrences, motions, shocks, are the axiomatic predications of multiverses and parallel universes; death is when self (the witness consciousness; register of individual general ledger) leaves the body; ostensibly parallel seem to have (e) an objective; parallel universes donot (e) have objectives; their paradigm of relational content, differentiated system of expressly oriented actions with primary focus and locus of homologues receptiveness and differentially instrumental activity, variable universalism and particularism, imperative compatibilities and structural variabilities, interactional dynamical orientation, institutionalization and internalisation of pattern variables common attitudinal orientation of constituionalisation of internalized dispositions, and a qualitative gradient of structural differentiation and ascribed particularistic solidarity abstraction or interactional dynamics, internal differentiation, structural morphology, formal characterization, concept formulation, phenomenological methodologies, constituent structure, transformational minimal condition, paradigmatic feasibilities, programmatic plausibilities, comparative variability, normative aspect of expectational prediction, affection- appreciation, awareness- discernment, emotion-feeling, gut reaction, heart insight, intuition, judgment, keenness, perceptiveness, rationale, sensation, sense, sensitiveness, sensitivity, sentiment, susceptibility, taste, vibes, admiration, aesthetic sense, affection, appraisal, assessment, attraction, awareness, cognizance, commendation, comprehension, enjoyment, esteem, estimation, grasp, high regard, knowledge, liking, love, perceptional realization, recognitional regard, relish, respect, responsiveness, sensibility, sensitiveness, sensitivity, sympathy, understanding, valuation, acknowledgment, airing, baring, , confessional defenselessness, denudation- denunciation, disclosure, display, divulgence-exhibition, hazard, introduction, jeopardy, laying open, liability, manifestation, nakedness, openness, peril, presentation, publicity, revelation, risk, showing, susceptibility , susceptiveness,susceptivity, unfolding, unmasking, unveiling, vulnerability, vulnerableness, action, affection, appreciation and ardor, behavior, capacity, compassion, concern, cultivation and culture, delicacy, discernment and discrimination, emotion, empathy, faculty, fervor, fondness, heat, imagination, impression and intelligence, intensity and intuition, judgment, keenness- palpability, passion, pathos, pity, reaction, refinement, sensibility, sensitivity, sentiment, sentimentality , sharpness, spirit, sympathy, tangibility, taste, tenderness, understanding, warmth, fond memories, hearts and flowers, homesickness, longing, pining, reminiscence, ,schmaltz, sentimentality wistfulness, yearning satiation is only ostensible; their job is to get the job done; their business is to mind other's business ;all laws of physics and finance breakdown; it is antilaw,piscatorial Piratish and bubonic bucaneerishness; there is free transactions between in multiverses; when reflected on the screen of consciousness they appear as extant existential universe. Transactions are astronomical and gratification deprivation, glorification and mortification incalculable; they have no barriers of region, religion, language which they create for others. theirs objectives are: corruption criminality, debasement debauchery, degradation evil immoral lewdness licentiousness, perversion sinfulness, vice viciousness, vileness wickedness, improbity corruption, atrocity decadence, degeneration degradation, depravity evil, immorality impurity, infamy iniquity, looseness lubricity, perversion profligacy, sinfulness turpitude,vice viciousness, vulgarity wickedness,

disgrace bad reputation, abasement abuse, baseness black eye, blemish blur, brand comedown,

contempt contumely, corruption culpability, debasement debasing, defamation degradation, derision disbarment, discredit disesteem, disfavor dishonor, disrepute disrespect, humbling humiliation

ignominy ill repute, infamy ingloriousness, meanness obloquy,odium opprobrium, pollution ,put-down reproach, scandal scorn, slander slight, slur spot, stain stigma, taint tarnish, turpitude venality, enormity Horribleness , abomination atrociousness, atrocity crime and the positive aspectionalities thereof .let there not be any incursions where evil mercenaries in the garb of mendicants thrive with adversely antagonistic, inexorably irreconcilable, antithetically antipodal, diametrically opposed, repugnantly retrogressive, inimically inverse, violatively unsimilar, diversely dissimilar, antipathetically anti thetical, conflictingly combative, obstructively pugnacious, inimically obstructive, repellently restrictive, disputatious gainsaying or conformingly pugnacious Manichaean artifice, agathokakological malevolence, agley chicane fourberie, fraud, furtiveness, gambit, awry and bad ,flagitious mechanizations, cacodemonic gambit, hanky-panky, intrigue, machination, deprecatory and diabolic underhandedness and wiles, energumenical skullduggery, execrable and goetic chicanery, lenocinant stratagem, malefic and maleficent strategy, malominous sell, sellout, sham subterfuge, peccable, humbug, imposture, misrepresentation peccant fraud, fraudulence, hoax, qued , scelerate pretense, ruse, sell, sellout, sham stratagems' of maladroit manouevures , sinistral ,tortious and venal sophistry, contingency enterprise, endangerment emprise, jeopardizing adventure, jejune jeremiad, avoidable inertia, latent passiveness . statement for Mephistophelean mercenaries philosophy merges with ontology; ontology merges with univocity of being; analogy has always a theological vision; not a philosophical vision; one becomes adapted to the forms of god; self and world; the univocity of being does not mean that there is one and the same being; on the contrary, beings are multiple and different they are always produced by disjunctive synthesis; and they themselves are disintegrated and disjoint and divergent; membra disjuncta.the univocity of being signifies that that being is a voice that is said and it is said in one and the same "consciousness". everything about which consciousness is spoken about being is the same for everything for which it is said like gravity; it occurs therefore as an unique event for everything; for everything for which it happens; eventum tantum; it is the ultimate form for all of the forms; and all these forms are disjointed; it brings about resonance and ramification of its disjunction; the univocity of being merges with the positive use of the disjunctive synthesis, and this is the highest affirmation of its univocity like gravity; it is the eternal resurrection or a return itself, the affirmation of all chance in a single moment, the unique cast for all throws; a simple rejoinder for Einstein's god does not play dice; one being, one consciousness, for all forms and all times. a single instance for all that exists, a single phantom for all the living; a single voice for very hum of voices; or a single silence for all the silences; a single vacuum for all the vacuums; consciousness should not be said without occurring; if consciousness is one unique event in which all the events communicate with each other; univocity refers both to what occurs to what it is said. This is attributable to all states of bodies and states of affairs and the expressible of every proposition. So univocity of consciousness means the identity of the noematic attribute and that which is expressed linguistically and sense fully. Univocity means that it does not allow consciousness to be subsisting in a quasi state and but expresses in all pervading reality. Negative energy stabilising wormholes are considered candidates for (er) darkmatter. An analysis of negative energy might be a useful ingredient of the thoughts of travel at speeds more than the velocity of light. Peirce explains that an "imperfect continuum" possesses "topical singularities, or places of lower dimensionality" which break continuity, while "the parts of a perfect continuum have the same dimensionality as the whole." (CP 4.642) Circular continua without singularities are time and space. (CP 6.210-212) By using math as his lens, Peirce envisioned singularities or lower dimensional holes in the imperfect cosmologic continuum, while maintaining that a probabilistic law of chance exists that entropy decreases **(Wikipedia).** On the side of philosophy**,** quite explicitly, Deleuze provides a critique of Husserl's "sleight-of-hand" change from a static categorical phenomenology to one supposedly more dynamically constitutive of reality. This a clear cut **chagrined circumvention**, **contraventional curbing**, **defeated disgruntlement**, **dissatisfactional downer**, **dragged failure**, **fizzled foil**, **grievance hindrance**, **impedimental irritation**, letdown, nonfulfillment, nonsuccess, obstruction, old one-two, **resent mental setback**, unfulfillment of the earlier theories makes Sartre contend that human existence is a conundrum whereby each of us exists, for as long as we live, within an overall condition of nothingness (nothing-ness)—that ultimately allows for free consciousness. But simultaneously, within our being (in the physical world), we are constrained to make continuous, conscious choices. It is this dichotomy that causes anguish, because choice (subjectivity) represents a limit on freedom within an otherwise unbridled range of thoughts. Subsequently, humans seek to flee our anguish through action-oriented constructs such as escapes, visualizations, or visions (such as dreams) designed to lead us toward some meaningful end, such as necessity, destiny, determinism (God), etc. Thus, in living our lives, we often become unconscious actors—Bourgeois, Feminist, Worker, Party Member, Frenchman, Canadian or American—each doing as we must to fulfill our chosen characters' destinies. However, Sartre contends our conscious choices (leading to often unconscious actions) run counter to our intellectual freedom. Yet we are bound to the conditioned and physical world—in which some form of action is always required. This leads to failed dreams of completion, as Sartre described them, because inevitably we are unable to bridge the void between the purity and spontaneity of thought and all-too constraining action; between the being and the nothingness that inherently coincide in our self. Deleuze insists on the absolute non-resemblance between what conditions (metastable, pre-individual plane of singularities) and what is conditioned (actualized or the individuated 'thing'). Only then do "the conditions of the true genesis become apparent," Deleuze writes (Logic of Sense 105). Without addressing this issue, Deleuze's borrowings from Simondon, Lautman and structuralism remain untethered. Because of Bowden's decision to completely sidestep Deleuze's overt negotiations with phenomenology, his otherwise sophisticated commentary suggests a pedagogical narrowness. If, the omission of phenomenology strengthens Bowden's focus on the ontological priority of the event over substantial ontologies via the genealogy of figures and movements Deleuze outlines, it also incompletely articulates the problem of the sense-event as Deleuze formulates it. We have lost any idea of whom Deleuze takes to be his primary adversary, against whom he stakes out his position. This worry is most clearly manifested in Bowden's description of Deleuze's ontological prioritizing of events as offering a "transcendental ontology." For Bowden Deleuze's transcendental ontology defines events that "are ontologically prior to substances, 'all the way down'" (82). But Bowden provides a second definition: it is that the priority of events over worldly individuals means that the world of events "is not something external to the conditions of knowledge" (69). **SEAN BOWDEN the Priority of Events: Deleuze's Logic of Sense Sean Bowden, the Priority of Events: Deleuze's Logic of Sense, Edinburgh University Press, 2011, 296pp., $40.00 (hbk), ISBN 9780748643646. Reviewed by David Scott, Coppin State University Weltschmerz, agony, apprehension, blues, depression, dread, mid-life crisis, misgiving, nervousness, uneasiness, angst were expressed with such effulgent words………… aggrandizement-amplification, caricature and crock, understatement- unembellishment, elocution-emphasis, enunciation-inflection, announcement, argument, articulational assertion, asseverational choice of words, commentary and communication, declaration and definition, delivery, diction, elucidation, emphasis, enunciation-execution, explanation, exposition-formulation, idiom, interpretation and intonation about the human predicament is brought out in Being and Nothingness. Being and Nothingness offers a critique of Sigmund Freud's theory of the unconscious, based on the claim that consciousness is essentially self-conscious. Sartre also argues that Freud's theory of repression is internally flawed. According to Sartre, in his clinical work, Freud encountered patients who seemed to embody a particular kind of paradox—they appeared to both know and not know the same thing. In response, Freud postulated the existence of the unconscious, which contains the "truth" of the traumas underlying the patients' behavior. This "truth" is actively repressed, which is made evident by the patients' resistance to its revelation during analysis. Yet what does the resisting if the patients are unaware of what they are repressing? Sartre finds the answer in what Freud calls the "censor". "The only level on which we can locate the refusal of the subject," Sartre writes, "is that of the censor.** The Holographic Principle, as conceived in current physics, applies to fields, and perhaps, even to more elementary entities, called strings and branes. These more elementary entities remain hypothetical at the time of this writing. There are many layers between the level of fields and that of neurons. We know that neurons are surrounded by a surface phospholipid membrane, which supports an electrochemical process that is fundamentally necessary to human experience. As the information supported by the membrane surface according to the Holographic Principle is proportional to its area, we should expect to find that the neural correlates of consciousness most clearly associated with those parts of the neuron that have the have a high proportion of neuronal surface area, and, in particular, receptive surface area. Dendrites account for an average of about 90% of the neuron is receptive surface area (Wong, 2002), and so would be expected to be the most important neural structures in information processes. We find this to be true **The Holographic Principle Theory of Mind MARK GERMINE Institute for Psycho science (Wikipedia).** Discordant-discrepant, dissonant-hard-line, implacable, incompatible, incongruous- inconsistent, inexorable-inflexible, inharmonious-intransigent, opposed, reluctant, unappeasable, uncompromising, unfriendly some of these expatiations and enumerations might sound, a more generalised interpretations is given by a Vedantin. Look at this arresting passage: The teacher continued to be silent. When addressed a second and third time he said: "I am teaching, but you do not follow. The Self is silence." The undetermined and unthinkable character of the Brahman is a consequence of the absolute's eternal and immutable nature. To concede the existence of a real universe is, from the Vedantin's point of view, to posit the existence of a reality apart from the Brahman. Nor can we simply identify a real universe with the absolute unless we are prepared to compromise its unchanging, absolute status. The criterion of authenticity is immutability. Reality never changes; only that which is less than real can appear to do so. Reality is constant in the midst of change. What this means essentially is that there is change although nothing changes. This impossible situation is reflected in the ultimate impossibility of change itself. That which does not exist prior to its changing and at the end, after it has changed, must be equally non-existent between these two moments. Although the world of change appears to be real, it cannot be so. Change, according to the Vedantin, presupposes a loss of identity. Reality cannot suffer transformation; if it were to do so, it would become something else and the real would be deprived of its reality. The immortal can never become mortal, nor can the mortal become immortal. The ultimate nature of anything cannot change. Change of any sort is merely apparent (vivarta); the world of change and becoming is a false super- imposition (adhyaropa, adhyasa) on the absolute. In cosmic terms, the mistake (bhranti) consists of the supposition that the real Brahman is the unreal universe and the unreal universe is the real Brahman. In microcosmic terms, it is the mistake of falsely conceiving the body, mind or even one's personality to be the Self. In the same way as the image of a snake is falsely superimposed on a rope, similarly the universe is falsely projected onto the real substratum, the Brahman. Ignorance is not merely a personal lack of knowledge, but a cosmic principle. As such it is called "Maya," the indefinable factor (anirvacaniya) that brings this mistake in identity about. The reality status of this cosmic illusion is also indefinable: on the one hand it is not Brahman, the sole reality; on the other hand it is not absolutely non-existent like a hare's horn or the son of a barren woman. Brahman is the source of world appearances only in the sense of being their unconditioned ground or essential nature. The universe is false not because it has no nature of its own but because it does have one. Just as the illusion of a snake disappears when one sees that it is nothing but a rope, similarly cancellation (badha) of the empirically real occurs when the absolute reality of the Brahman is realised. Thus, according to Vedanta, appearance implies the real, while the real need not imply appearance. To appear is essentially to appear in place of the real, but to be real is not necessarily to appear. All things -exist because the absolute exists. It is their Being. Thus the very existence of phenomena implies their non-existence as independent realities. When they are known to be as they are, in the fullest sense of their existence, their phenomenal nature disappears leaving the ground of Being naked and accessible. This approach was validated by a critique of experience. The Vedanta established that space, time and the other primary categories of our daily experience can have no absolute existence. It was therefore necessary to make a distinction between relative truths — that accepted by the precritical common man — and an absolute truth discovered at a higher level of consciousness. The Saiva absolutist 17 rejects any theory that maintains that the universe is less than real. From his point of view a doctrine of two truths, one absolute and the other relative, endangers the very foundation of monism. The Kashmiri Saiva approach is integral: everything is given a place in the economy of the whole. It is equally wrong to say that reality is either one or diverse. Those who do so fail to grasp the true nature of things which is neither as well as both. "We do not" says Abhinavagupta, "base our contention that [reality] is one because of the contradictions inherent in saying that it is dual. It is your approach {paksa) that accepts this [method] While, if [duality and oneness] were in fact [to contradict each other], they would clearly be two [distinct realities]." The Vedantin, who maintains that non-duality is the true nature of the absolute by rejecting duality as only provisionally real, is ultimately landed in a dualism between the real and illusory by the foolishness of his own excessive sophistry (vacafadurvidya). Oneness is better understood as the coextensive unity (ekarasa) of both duality and unity. They are equally expressions of the absolute. Gopinath Kaviraj says: According to Sarikara, Brahman is truth and Maya is inexplicable (anirvacaniya). Hence the [Advaitin's] endeavour to demonstrate the superiority of Advaita philosophy is turned against his own system. It tarnishes the picture of its philosophical perfection and profundity. He cannot accept Maya to be a reality, therefore his non-dualism is exclusive. The whole system is based on renunciation and elimination and thus is not all-embracing.... By accepting Maya to be Brahman (brahmamayi), eternal (nitya) and real (satyarupa), Brahman and Maya [in the Tantra] become one and coextensive. **The Doctrine of Vibration: An Analysis of the Doctrines and Practices of Kashmir Shaivism Mark S. G. Dyczkowski. Concept of being from Shaivite point of view:** Solutional behaviour and stability analysis of such systems is of paramount importance, notwithstanding the assumptions made which are not farfetched, in that it throws light on the fact whether they could be candidates for yet unsolved problems, providing Autheticative determination, unimpeachable validation, incontrovertible establishment, apodictic evidence, reliable roll out, unfailing cinquecento **quattrocento trecento,** incontrovertible indication for the wide amplitudinal ramificatory usage of the thesis propounded. The world is now the other person's world, a foreign world that no longer comes from the self, but from the other. The other person is a "threat to the order and arrangement of your whole world...Your world is suddenly haunted by the Other's values, over which you have no control"(Satre: being and Nothingness) Sartre states that many relationships are created by people's attraction not to another person, but rather how that person makes them feel about themselves by how they look at them. This is a state of emotional alienation whereby a person avoids experiencing **their subjectivity by identifying themselves with "the look" of the other**. The consequence is **conflict**. In order to maintain the person's own being, the person must control the other, but must also control the **freedom of the other "as freedom**". These relationships are a profound manifestation of "bad faith" as the for-itself is replaced with the other's freedom. The purpose of either participant is not to exist, but to maintain the other participant's looking at them. This system is often mistakenly called "love", but it is, in fact, nothing more than emotional alienation and denial of freedom. In essence we are always simulating and selling ourselves at the cost of our freedom. Both as a script writer and participant consciousness, human beings experienceâ complete subjective feelings and sometimes absolute subjective feelings, which if remains unchecked might lead to pathological ramifications. (italics mine) Perspicuous forbearance, Sophisticated seasoning, Partcipational observation, Background actuality, Existential worldliness, Existential strife, Predicational anteriorities, Character consonance, Ontological consonance, Primordial exactitude, Phenomenological correlates, Accolytish representation, Atrophied asseveration. Anamensial alienisms, Anchorite aperitif, Arcadian Atticism all delineated in the conditionalities and functionalities and orinetatilities of the system which incorporate the rules and regulations, axiomatic predications and postulation alcovishness of the foregoing state form the bastion, pillar, post, stylobate and sentinel of the classification scheme and doxa. appropriate and diagnostic, differentiating-discriminating, distinctive-distinguishing, emblematic- especial, essentially exclusive, fixed, idiosyncratic-inborn, inbred, indicative and individual, individualistic-inherent, individualizing and ingrained, inherent, innate, local, marked, native, normal, original, particularly- peculiar, personal, private, proper, regular, representative-singular, special, specific, symbolic, symptomatic- unique these form the classification and stratification measure that is suitable notwithstanding the constancy in many a case, as in gravity, which depends on the mass and distance for two given objects**.** Like Kant and Bergson, Deleuze considers traditional notions of space and time as unifying forms imposed by the subject. He therefore concludes that pure difference is non-spatio-temporal; it is an idea, what Deleuze calls "the virtual". (The coinage refers to Proust's definition of what is constant in both the past and the present: "real without being actual, ideal without being abstract.") Proust, Le Temps Retrouvé, ch. III: see the fourth line from the bottom of this page, or, in English translation, the thirteenth paragraph here: "I began to discover the cause by comparing those varying happy impressions which had the common quality of being felt simultaneously at the actual moment and at a distance in time, because of which common quality the noise of the spoon upon the plate, the unevenness of the paving-stones, the taste of the madeleine, imposed the past upon the present and made me hesitate as to which time I was existing in. Of a truth, the being within me which sensed this impression, sensed what it had in common in former days and now, sensed its extra-temporal character, a being which only appeared when through the medium of the identity of present and past, it found itself in the only setting in which it could exist and enjoy the essence of things, that is, outside Time. [...] **Nothing but a moment of the past Much more perhaps; something which being common to the past and the present, is more essential than both. [...] a marvellous expedient of nature had caused a sensation to flash to me—sound of a spoon and of a hammer, uneven paving-stones**—simultaneously in the past which permitted my imagination to grasp it and in the present in which the shock to my senses caused by the noise had effected a contact between the dreams of the imagination and that of which they are habitually deprived, namely, the idea of existence—and thanks to that stratagem had permitted that being within me to secure, to isolate and to render static for the duration of a lightning flash that which it can never wholly grasp, a fraction of Time in its pure essence. When, with such a shudder of happiness, I heard the sound common, at once, to the spoon touching the plate, to the hammer striking the wheel, to the unevenness of the paving-stones in the courtyard of the Guermantes' mansion and the Baptistry of St. Mark's, it was because that being within me can only be nourished on the essence of things and finds in them alone its subsistence and its delight. It languishes in the observation by the senses of the present sterilised by the intelligence awaiting a future constructed by the will out of fragments of the past and the present from which it removes still more reality, keeping that only which serves the narrow human aim of utilitarian purposes. But let a sound, a scent already heard and breathed in the past be heard and breathed anew, simultaneously in the present and in the past, real without being actual, ideal without being abstract, then instantly the permanent and characteristic essence hidden in things is freed and our true being which has for long seemed dead but was not so in other ways awakes and revives, thanks to this celestial nourishment"While Deleuze's virtual ideas superficially resemble Plato's forms and Kant's ideas of pure reason, they are not originals or models, nor do they transcend possible experience; instead they are the conditions of actual experience, the internal difference in itself. "The concept they [the conditions] form is identical to its object."[Desert Islands, p. 36.] A Deleuzean idea or concept of difference is therefore not a wraith-like abstraction of an experienced thing, it is a real system of differential relations that creates actual spaces, times, and sensations. [See "The Method of Dramatization" in Desert Islands, and "Actual and Virtual" in Dialogues. In fact it not as if the style and substance of science and philosophers have been entirely different. look at the conformality and consonance in the Gaussian Theory and Deleuze's statements on identity and the loss of it in the following passage………That is, identity is a continuous process that finds its limit in exhaustion. As Deleuze will write, "…the logical relation of causality is inseparable from a physical process of signalling, without which it would not be translated into action. By 'signal' we mean a system with orders of disparate size, endowed with elements of dissymmetry; by 'sign' we mean what happens within such a system, what flashes across the intervals when a communication takes place between disparates. The sign is indeed an effect, but an effect with two aspects: in one of these it expresses, qua sign, the productive dissymmetry; in the other it tends to cancel it" (dr, 20). An actualized entity just is such a signal-sign system, remaining in perpetual communication with the virtual multiplicity it actualizes, constituting its own elements and identity. Such is Deleuze's account of what Badiou refers to as the operation of the "count-for-one"… an operation that is immanent to being itself and energetic in character. yet how are we to discern the local nature of ontological situations, the manner in which there is no global, overarching global situation in which all local situations are embedded as if parts of a whole? in part the above passage already responds to this question. if series must be brought into relation to communicate in order for causality to occur, and if the resonance of series is always a matter of chance, of a throw of the dice, like Lacan's objet a where no series enjoys primacy of model over copy, then all we have are local situations without a total situation. Unlike Heidegger's analysis of Dasein where Dasein is always being-in-the-world, Deleuze's simulacra or actualizations are always divergent, enjoying only local relations. Heidegger argues that in order to understand the being of Dasein we must understand the manner in which Dasein is a being-in-the-world. By contrast, Deleuze's concept of multiplicity provides us with the principle of a new structuralism, of a new local ontology, that allows us to understand the immanent organization of a multiplicity without referring it to an embedding global space. as DeLanda so beautifully puts it in relation to the mathematician gauss, "…when gauss began to tap into these differential resources, a curved two-dimension surface was studied using the old Cartesian method: the surface was embedded in three-dimensional space complete with its own fixed set of axes; then, using those axes, coordinates would be assigned to every point of the surface; finally, the geometric links between points determining the form of the surface would be expressed as algebraic relations between the numbers. but gauss realized that the calculus, focusing as it does on infinitesimal points on the surface itself (that is, operating entirely with local information), allowed the study of the surface without any reference to a global embedding space. basically, gauss developed a method to implant the coordinate axes on the surface itself (that is, a method to implant the coordinate axes on the surface itself (that is, a method of 'coordinatizing' the surface) and, once points had been so translated into numbers, to use differential (not algebraic) equations to characterize their relations. as the mathematician and historian Morris Kline observes, by getting rid of the global embedding space and dealing with the surface through its own local properties, 'gauss advanced the totally new concept that a surface is a space in itself'" (intensive science and virtual philosophy, 11-12).according to the old Cartesian method, we can only outline the properties of a space by relativizing it to a global space in terms of which it is then mapped. by contrast, gauss is able to explore a space in terms of its intrinsic metric and organization as a local space, without referencing it to a whole of which it is conceptualized as a part. **The Image of Thought**

"Image of thought "permeates both popular and philosophical discourse. According to this image, thinking naturally gravitates towards truth. Thought is divided easily into categories of **truth and error**. The model for thought comes from the educational institution, in which a master sets a problem and the pupil produces a solution which is either true or false. This image of the subject supposes that there are different faculties, each of which ideally grasps the particular domain of reality to which it is most suited. In philosophy, this conception results in discourses predicated on the argument that "**Everybody knows...**" the truth of some basic idea. Descartes, for example, appeals to the idea that everyone can at least think and therefore exists. Deleuze points out that philosophy of this type attempts to eliminate all objective presuppositions while maintaining subjective ones. Deleuze maintains, with Artaud, that real thinking is one of the most difficult challenges there is. Thinking requires a confrontation with stupidity, the state of being formlessly human without engaging any real problems. One discovers that the real path to truth is through the production of sense: the creation of a texture for thought that relates it to its object. Sense is the membrane that relates thought to its other. Accordingly, learning is not the memorization of facts but the coordination of thought with a reality. "**As a result, 'learning' always takes place in and through the unconscious, thereby establishing the bond of a profound complicity between nature and mind".** Deleuze's alternate image of thought is based on difference, which creates a dynamism that traverses individual faculties and conceptions. This thought is fundamentally energetic and signifying: if it produces propositions, these are wholly secondary to its development. Philosophy merges with ontology; ontology merges with univocity of being; analogy has always a theological vision; not a philosophical vision; one becomes adapted to the forms of god; self and world; the univocity of being does not mean that there is one and the same being; on the contrary, beings are multiple and different they are always produced by disjunctive synthesis; and they themselves are disintegrated and disjoint and divergent; membra disjuncta.the univocity of being signifies that that being is a voice that is said and it is said in one and the same "consciousness". Everything about which consciousness is spoken about being is the same for everything for which it is said like gravity; it occurs therefore as an unique event for everything; for everything for which it happens; even tum tan tum;it is the ultimate form for all of the forms; and all these forms are disjointed; it brings about resonance and ramification of its disjunction; the vorticity of being merges with the positive use of the disjunctive synthesis, and this is the highest affirmation of its univocity like gravity; it is the eternal resurrection or a return itself, the affirmation of all chance in a single moment, the unique cast for all throws; a simple rejoin der for Einstein's god does not play dice; one being, one consciousness, for all forms and all times. a single instance for all that exists, a single phantom for all the living; a single voice for every hum of voices or a single silence for all the silences; a single vacuum for all the vacuousness consciousness should not be said without conjuring if consciousness is one unique event in which all the events communicate with each other; univocity refers both to what occurs to what it is said. The attributable to all states of bodies and states of affairs and the expressible of every proposition So univocity of consciousness means the identity of thé noematic attribute and that which is expressed linguistically and sense-fully. Univovity.We mean that it does not allow consciousness to be subsisting in aquasi state and but expresses in all pervading reality. (Reference: LOS: Deleuze) Deleuze sometimes spoke of getting up behind an author and "creating a monster", as if his reading methodology somehow consisted of a distortion of the philosopher's or author's thought. Certainly there is a case to be made for this with regard to the process of deterritorialization, where something is wrested from a territory and deterritorialized upon a new territory, like the animal paw that is deterritorialized from the earth and reterritorialize on the branch. however, it seems to me that the more interesting aspect of Deleuze's approach to other philosophers and art is not so much his "monstrous creations" (i seldom find them particularly monstrous), but rather their Gaussian or Riemannian style, where he explores them in terms of their own internal organization and metric, without reducing them to something alien such as history, society, biology (reductivism), or the signifier. What we find in Deleuze's approach to phenomena is a Gaussian technique. for instance, take Deleuze's books on cinema, his book on Francis bacon, or his study of sacher-masoch. In the first instance, Deleuze's carefully separates cinema from narrative and the signifier, studying it in terms of its specific organization pertaining to the production of images. in the case of bacon, Deleuze doesn't look for an underlying narrative or "meaning", but instead studies the manner in which bacon composes and organizes his images and lines, both in terms of their production and actuality, so as to liberate a logic of sensation.

finally, in approaching sacher-masoch, Deleuze allows Sacher-Masoch's novels to speak for themselves in terms of their desire and relation to pain, stalwartly refusing to reduce masochism to the complement of sadism. in each case, we have a local exploration of a "space" of multiplicities that is extremely precise. Sean Bowden the priority of events: **Deleuze's logic of sense sean Bowden, the priority of events: Deleuze's logic of sense, Edinburgh university press, 2011, 296pp., $40.00 (hbk), isbn 9780748643646 Reviewed by David Scott, Coppin state university and Gaussian spaces and multiplicities a note on Gaussian spaces and multiplicities posted by larval subjects under uncategorized.** What you "see" is not always what you "get." Many people mistakenly take their own visions literally without "seeing through" the various possibilities that are outside their belief system, knowledge or skill base. Deeper reality is not remote in the physical sense but in a psychological sense. The archetypes of the collective unconscious are arrayed behind the scenes of current worldwide conditions, of crisis and confusion. They mirror our own states back at us, whether we perceive them as such or interpret them plausibly or not. The noise of ordinary consciousness and beliefs drowns out the signal. Unconsciousness is the background of our ordinary awareness. Our organism is very much at the center of such effects. The organismic source is our human bodies and the focus of human consciousness. The fantasy principle dethrones (e) reality, but can be dissociative or compensatory. The human mind is (=) a meme-Scape. Pre-conceived concepts vie with (e&eb) structures, concepts with images. Like scientists who ignore (e) assumed truths, we leapfrog over (e&eb) our beliefs and personality deficits, claiming (eb) idiosyncratic imagination is (=) literal reality. It couldn't be further from the truth and symbolism is utterly lost. The metaphor that might heal us enslaves (e) us. Perhaps images like the holographic universe have an implicate order. Can we have a sense of the cosmos in the world without projecting myriad fantasies on it that we embrace literally? Has the world become so horrible it is unreasonable to be realistic? We may need to look at our drives and wishes, rather than the fantasy content. Psyche constructs reality. Our experience of so-called reality is always mediated by our image of it. Even if all the contents of the psyche are real, that doesn't mean they are realistic. That psyche is real is still a radical proposition, but psychic politics certainly color the self-image and ideas of everyone. We observe and participate with images. It is not a question of nature or nurture (genes alone or experience alone). Rather, everything is (=) both. We inherit (e&eb) the structures that make our experience (=) what it is. But the structure itself is "empty," and each human culture "fills" it with its own specific adaptations. It is difficult to define an archetype and set boundaries that distinguish it from others. In a hologram each part contains all the information but in lower resolution. Archetypes have this holographic quality. There are patterns within patterns within patterns. Some overlap with others, and some are nested inside others. Archetypal realities, passed on through DNA, are expressed in distinctive neuronal tracts in the brain. They include customs and laws regarding property, incest, marriage, kinship, and social status or roles; myths and legends; beliefs about the supernatural; gambling, adultery, homicide, schizophrenia, and the therapies to deal with them. A mythic and visionary language of immediate experience encompasses themes of deepest, highest, and ultimate concern. Most fantasy-based individuals are at a complete loss to coherently explain their own conventional behavior much less anomalous events and their deep meaning, much less the cultural unconscious or mythological unconscious matrix. But they try, and become utterly entrenched in their belief that they are right about the nature of the world and reality. We have pseudo-memories about (e&eb) our personal lives. Why not more so for our collective life? The subject matter often revolves around catastrophe, creation and the mythopoeic forces of mankind. Ignorant of such dynamics, interpretive mistakes and displaced psychic contents proliferate into (e&eb) errors of fact. Propaganda, media distortions, memes, and disinformation compound the social problem of misapprehension further. Shameless self-promotion by personalities of such ideas leads to cults. They make up myths about the myths of by-gone eras. Roiling unconscious images can be fatally confusing. Thought illusions culminate in projections and projections of mythology. Jung suggested symbols live only as long as they are pregnant with meaning. Philosophy arose from criticism of myth, from discussing and challenging it. In science, we criticize, reject and eliminate theories. At the edge of the abyss of the unknown, new signs and symbols emerge. Credible theories and paradigms must include biology, physics, and neurophysiology. One of the reasons people "see God", or a guru, or anomalies may be because our brains are constructed to see reality through the eyes of others. There are heaps of mirror neurons which are there to make us feel the 'other'. Mirror neurons do for psychology what DNA did for biology. They provide a unifying framework and help explain a host of mental abilities. As in the psychochemical processes of empathy or falling in love, a complex feedback loop sustains a state of mind. But when we empathically transpose ourselves into someone else's position, we expose ourselves to that reality -- cognitively and emotionally. The unconscious complicates empathy, both ways. Mirror neurons might well play a role in bonding, language and self-awareness. Naively, we take too much as self-evident. But 'seeing' does not always 'believe', though many make this error or leap in logic and formulate their choices and future accordingly. Yet, there is only one way to learn what consciousness is. Experience. But we have no satisfactory explanatory edifice for consciousness. Would such a theory release in each of us our own inner knowledge of the creativity of our own consciousness, and its infinite possibilities? The problem is trying to define a verb, a dynamic, as if it were a noun. But we do recognize the effect of consciousness. It functions to mediate states of consciousness, high and low psychobiological arousal. Consciousness is the subconscious lifted up by the physical body. When the body fails, the consciousness collapses back into the subconscious. All our thoughts come from the subconscious which can see our intentions but not our world. This relates somehow to intention being imaginary and not of the physical frictionized world (King). Gerald Edelman postulates that the flows of information in the brain are mediated through're-entrant' feedback loops. As evolution provides new cognitive functions, new re-entrant loops are established. Even language itself is an archetype -- a chaotic field of dynamic associations. A subtle net of tropes, grammar, symbols, and meaning, the program language begins in limbic resonance. Some phenomena generate their own language patterns, nomenclature, and internal coherence of meaning and representation. In a holographic universe, even time and space could no longer be viewed as (=) fundamentals. Because concepts such as location break down in a universe in which nothing is truly separate from anything else, time and three-dimensional space would also have to be viewed as projections of this deeper order. At its deeper level reality is a sort of super hologram in which the past, present, and future all exist simultaneously. This suggests that given the proper tools it might even be possible to someday reach into the super holographic level of reality and pluck out scenes from the long-forgotten past. Or not. A fantasy of such penetration or phenomenon inside the head is not the same as that penetration. **Jung in the 21st Century: Synchronicity and science By John Ryan Haule Mind Control Countermeasures.** Adversely antagonistic, inexorably irreconcilable, antithetically antipodal, diametrically opposed, repugnantly retrograde, inimically inverse, violatively unsimilar, diversely dissimilar some statements in Vedanta, it is not superfluous or redundant. It is evolutionary. Autheticative determination, unimpeachable validation, incontrovertible establishment, apodictic evidence, reliable roll out, unfailing cinquecento **quattrocento trecento,** incontrovertible indication of the evolutionary process towards understanding is ever present in all, its thematic and discursive form. it is the relentless holding on to a theory this is despicable albeit the theory is not. Look at this paragraph. It is the 'I am the body/mind' belief that gives rise to the 'I am not (e) the world' belief. These two beliefs are (=) co-created."Consciousness projects (e&eb) the appearance of the mind, body and world by taking the shape of thinking, sensing and perceiving." "Attention is Consciousness with (e&eb) an object. When the object vanishes, attention simply remains what it always is, (=) Consciousness.""There is (=) no purpose to (e) meditation. The purpose is already accomplished." "Everything that is experienced is experienced by (e), through,(e&eb) in (eb) and as (=) Consciousness." "The seen cannot be separated from seeing and seeing cannot be separated from (e) Consciousness." "The Reality of any experience is not hidden in the appearance; it is expressed by the appearance." "Once we see that everything is Consciousness... Maya still dances, but it is a dance of love not seduction." There are some truly excellent sections such as a long one taking, as a starting point, the following quotation from the painter Cézanne: "Everything vanishes, falls apart, doesn't it? Nature is always the same but nothing in her that appears to us lasts. Our art must render the thrill of her performance, along with her elements, the appearance of all her changes. It must give us a taste of her Eternity." Rupert begins: "That statement must be one of the clearest and most profound expressions of the nature and purpose of art in our era." And he goes on for some 14 pages to elaborate on this claim, examining the nature of the 'elements' Existence, appearance and Consciousness and their relationship. "This Reality is the support or ground of the appearance. The appearance may be an illusion, but the illusion itself is real. There is an illusion. It has Reality." He refers to the rope-snake metaphor and says that: "We do not see anything new. We see in a new way." "So that we know that nature is real, that there is something present, that there is a reality to it, even if everything that appears to us is insubstantial and fleeting." **The Transparency of Things' by Rupert Spira Book Review by Dennis Waite The following is a review of Rupert's book: 'The Transparency of Things: Contemplating the Nature of Experience'. There is an essay from the book here and the essay on Cézanne may be read at the awakened eye website For models see Mitigation Of Beam-Induced Backgrounds, Multi-Particle Azimuthal Correlations, Search For Extra Dimensions, Multi-Higgs-Boson Cascade, Top Quark Pair (Tt) Production Charge Asymmetry, ∆Y ≡ Yt − Yt¯, Reflects The Asymmetry In Tt¯ Production, Ultra-Relativistic Electrons And Other Letters Of Interest: A Synecdochal Syncretism: Et Lux In Tenebris Lucet: Light Shines In The Darkness Models.** What then is the relation of Higgs boson and consciousness? Functionalist approaches generally assume that conscious experience appears as a novel property at a critical level of computational complexity. On the surface this would seem to deal with issues 1 and 3, however a conscious threshold has neither been identified nor predicted, and there are no apparent differences in electrophysiological activities between non-conscious and conscious activity. Regarding the nature of experience (why we are not unfeeling "zombies") functionalism offers no testable predictions. Problem 2) of 'binding' in vision and self is often attributed by functionalists to temporal correlation (e.g. coherent 40 Hz), but it is unclear why temporal correlation per se should bind experience without an explanation of experience. As functionalism is based on deterministic computation, it is also unable to account for Penrose's proposed non-computability (4), or free will (5). Something may be missing. To address these issues, various proposals have been suggested in which macroscopic quantum phenomena are connected to the brain's known neural activity. For the problem of unitary binding, Marshall (1989) suggested that coherent quantum states known as Bose-Einstein condensation occurred among neural proteins (c.f. Penrose, 1987; Bohm and Hiley, 1993; Jibu and Yasue, 1995). Pre-conscious to conscious transitions was identified by Stapp (1992) with collapse of a quantum wave function in pre-synaptic axon terminals (c.f. Beck and Eccles, 1992). In another proposal, protein assemblies called microtubules within the brain's neurons are viewed as self-organizing quantum computers ("orchestrated objective reduction - Orch OR" e.g**. Penrose and Hameroff, 1995; Hameroff and Penrose 1996a; 1996b; c.f. Hameroff 1997; 1998a; 1998b; 1998c; 1998d). Stability analysis of such theories would certainly provide a gateway for further bringing in the "reality" in space time.** String theory suggests that the graviton particle would not be detected from a particle collision because it would have "jumped" into another dimension. So, if the graviton exists and the theory is correct, there should be a "gap" in the energy profile of all the particles ejected from the collision. To understand this, think of breaking the pack of balls in a game of pool. The total energy of all the balls after the collision will depend on the force with which the cue ball was hit. So, after the collision, the energy of all the balls is measured and added-up to make sure it is the same as the energy of the cue ball. BUT - imagine that there is some energy missing, because one of the pool balls has "gone missing" - into a higher dimension. (POSTED BY THEREALJEFFHAL**) Talbot says** "If the universe is a hologram, in some sense it suggests that there may be two very drastically different levels of reality: the concrete reality that we see when we look at [things]... and at some deep level there's a level of reality where everything dissolves into an ocean of energy that is holographically interconnected.". A theory of everything must encompass all the variations however contradictory it may be. Nor need any theory be sent in to grand limbo of oblivion and hibernation or a differentiated groundless less ness because there are some irregularities which are like audit discrepancies need to be rectified. Although the language of religion and science seem different, both are talking about the central order of nature relative to DNA and information, as is Peirce, Petrus, Bacon, and pharaonic Egypt. This path-ordering, active information suggests that the central pattern or law of our holographic cosmos may be modeled on the biophysical battleground of gene regulation in bacteriophage Lambda, one of nature's most efficient and highly evolved mechanisms identified by experimental praxis. Egyptian texts support that the Lambda lifestyles of lysogeny and lysis can be understood as two paths to two living systems, photosynthesis and its reversal chemiluminescence, the cosmic key for evolution of mind and continuity. The texts support that the Lambda genome is the world-heart of two ways. The viral lifestyle of lysogeny controlled by cI protein results in matter, classical spacetime, our world of projected shadow, photosynthesis, sexual genesis or vertical gene transfer, mind in the human body, and the imperfect continuum. In contrast, the viral lifestyle of lysis controlled by cro protein and lactose metabolism results in transformation to energy, the quantum, chemiluminescence, asexual genesis or HGT, mind in the cosmos, and the perfect continuum. Some scientists believe our cosmos is entangled with another (Chown 2007). On the holographic quantum level, perhaps this is just the competitive entanglement of cI and cro proteins cycling in perpetual motion—an inherent law of nature elucidating the assembly of things. In light of modern experiments, physicist John Wheeler (1988) speculated that the **act of conscious observation functions with quantum mechanics, catalyzing a probability or outcome**. So, if an observing consciousness has knowledge of the classical path and its magnetic field orientation, an act of measurement or choice might entangle space to reify the holographic quantum paths to a perfect continuum. Peirce guesses that to be drawn into a new system, a particle must have the right mass, the right velocity in the right direction, the right attraction, and it must present itself at the right point (EP 1. 270). Similarly, a finite probability exists for any particle that approaches the black hole event horizon to bounce back, dependent on the incoming particle's energy, its charge, and its projection of the orbital momentum on the axis of rotation of the black hole (Kuchiev 2003; 2004; 2004a), the same conditions in Egyptian texts (King 2004; 2006).Only an approximate conclusion remains: chance may be knowledge of the cosmos' holographic mode of operation and magnetic fields; habit breaking may result in the transformation of energy by a violation of the second kind; and evolution of mind or energy might be possible through HGT via a cosmic viral code of Lambda-genesis. "Order is simply thought embodied in arrangement;" (CP 6.490). Accordingly, the original meaning of the signs may relate to a viral biophysics of crystallized mind for human evolution via a natural chemical pathway to a perfect continuum. Again, this semiotics of evolvability and order recurs in time with the chaotic dream of reason that projects a pervasive falsification of our perceptual world. As Wallace Stevens envisions in "Connoisseur of Chaos", perhaps "the pensive man may see." **Peircean Process Metaphysics Origin of Science Quantum and Classical Laws Ancient Egyptian Evolutionary Biophysics** Adversely antagonistic, inexorably irreconcilable, antithetically antipodal, diametrically opposed, repugnantly retrograde, inimically inverse, violatively unsimilar, diversely dissimilar are the views of epistemologists in the analysis of raison d'etre of knowledge. Epistemology is the study of knowledge and those things closely related to it: justification, what it takes for you to be justified, the relation between knowledge and justification, whether you can have any justified beliefs at all, and if so, how you come to know (or justifiably believe) things, how you can use what you know (or justifiably believe) to come to know (or justifiably believe) other things, and whether and why it's valuable to know instead of merely having justified and true beliefs. The literature on epistemology is vast. Here's a very brief summary of some epistemological discussions. Concerning knowledge, many epistemologists think knowledge is justified true belief, where the justification you have is linked to the truth of the matter in the right kind of way, though what this way is a matter of debate; some epistemologists think knowledge can't be analyzed this way. Concerning justification's relation to knowledge, some epistemologists think we don't need to be justified to know, and some think we do need to be. Concerning what it takes to be justified, some epistemologists think that what it takes for you to be justified are only factors internal to the believer (Internalists). Others think it takes an external factor, like reliable or well-functioning cognitive faculties (Externalists). Skeptics argue that we can't have any justified beliefs at all, and many epistemologists reply to the skeptic's arguments. Concerning how we use what we know (justifiably believe) to come to know (justifiably believe) other things, some epistemologists (Foundationalists) argue that there are bedrock propositions that we know (justifiably believe), and we build our knowledge (justified beliefs) on those. Others (Coherentists) argue that there aren't bedrock propositions; rather, a set of beliefs is justified as a whole, and several beliefs can be mutually supporting. Concerning the value of knowledge, some argue that knowledge is intrinsically valuable. Others have argued that knowledge is valuable only because of the role it plays in practical reasoning, and others argue that knowledge isn't more valuable than justified and true belief, but there are other epistemic states such as understanding, that do have value above their proper subparts. **Edited by Matthew McGrath (University of Missouri, Columbia). It is not as if there is an anathema or misnomer in the philosophy or physics. Infact most of the pnysicists have used philosophical ideas towards the end of consummation of their their and their concomitant justification thereof.** The eternal return produces becoming-active. It is sufficient to relate the will to nothingness to the eternal return in order to realize that reactive forces do not return. However far they go, however deep the becoming-reactive of forces, reactive forces will not return. The small, petty, reactive man will not return.

Affirmation alone returns, this that can be affirmed alone returns, joy alone returns. Everything that can be denied, everything that is negation, is expelled due to the very movement of the eternal return. We were entitled to dread that the combinations of nihilism and reactivity would eternally return too. The eternal return must be compared to a wheel; yet, the movement of the wheel is endowed with centrifugal powers that drive away the entire negative. Because Being imposes itself on becoming, it expels from itself everything that contradicts affirmation, all forms of nihilism and reactivity: bad conscience, ressentiment..., we shall witness them only once. [...] The eternal return is the Repetition, but the Repetition that selects, the Repetition that saves. Here is the marvelous secret of a selective and liberating repetition. There is no need to remind the reader that neither the image of a centrifugal movement nor the concept of a negativity-rejecting repetition appears anywhere in Nietzsche's writings, and indeed Deleuze does not refer to any text in support of this interpretation. Further, one could highlight that Nietzsche never formulates the opposition between active and reactive forces, which constitutes the broader framework of Deleuze's interpretation. For some years, Marco Brusotti has called attention to the fact that Deleuze introduced a dualism that does not exist in Nietzsche's writings. To be sure, the German philosopher describes a certain number of **"reactive" phenomena (for example, in the second essay of the Genealogy of Morality, § 11, he talks about "reactive affects" [reaktive Affekte], "reactive feelings" [reaktive Gefühlen], reactive men [reaktive Menschen]); but these are nonetheless the result of complex ensembles of configurations of centers of forces that remain in themselves active.** Neither the word nor the concept of "reactive forces" ever appears in Nietzsche's philosophy. **After the discovery of the two principles of thermodynamics began a debate about the dissipation of energy and the thermal death of the universe which framed the modern renewal of the debate between the linear and circular conceptions of time**. Scientists such as Thomson, Helmholtz, Clausius, and Boltzmann and-by way of Kant, Hegel and Schopenhauer-philosophers such as Dühring, Hartmann, Engels, Wundt and Nietzsche have tried to address this problem by using the force of scientific argumentation and of philosophical discussion. Whoever believed in an origin and a final end to the motion of the universe (be it in the physical form of the gradual loss of heat, or in the metaphysical form of a final state of the "world process"), relied on the second principle of thermodynamics or on the demonstration of the thesis of Kant's first cosmological antinomy. On the contrary, those who refused to admit a final state to the universe used Schopenhauer's argument of infinity a parte ante-according to which if a final state were possible, it should already have established itself in the infinity of time past-to propose henceforth a number of alternative solutions. Scientists would propose the hypothesis that energy could have re-concentrated after a cosmic conflagration, thus reversing the tendency towards dissipation. Those belonging to the monistic and materialistic tradition relied on the first principle of thermodynamics and on the infinity of matter, space and time, and regarded the universe as an eternal succession of new forms. A certain critical agnosticism was widespread among scientists and philosophers, oftentimes through a reaffirmation of the validity of Kant's antonymic conflict, this movement avoided to take a stand on specifically speculative issues. Other German philosophers, like Otto Caspari, or Johann Carl Friedrich Zöllner, had reintroduced an organicist and pan-psychical conception of the universe, investing atoms with the ability to escape any state of balance. Indeed, it is probably one of Otto Caspari's works, The Correlation of Things (Der Zusammenhang der Dinge. Gesammelte philosophische Aufsätze (Bleslau: Trewendt, 1881)), which awakened Nietzsche's interest for all things cosmological, in that summer of 1881, in Sils-Maria. addressing Schopenhauer and Eduard von Hartmann's mystical pessimism according to which the world is the creation of a stupid and blind essence (which, after having created the world by mistake, comes to the realization that it had made a mistake and strives to return it to nothingness) Caspari stresses that it is nothing short of mystical to imagine that the world may have been borne out of a an originary and undifferentiated state. Where would it have drawn the first impulse? But, continues Caspari, even if the world had received this first impulse from some deus ex machina, there is no doubt that, in the temporal infinity of past time thus far, it would have either attained the end of the process (but this is impossible because the world would then have ended), or it would be necessarily bound to repeat indefinitely this original mistake, and the entire process that accompanies it. But then, what is the process of the world? We must now take one more step back and understand further the process of the world according to von Hartmann. Hartmann objects that the regressive movement postulated by Schopenhauer is possible only in thought: it remains nothing more than an "ideal postulate" with no real object and which "does not teach us anything about the real process of the world that unfolds in a movement contrary to this backwards movement of thought" (Hartmann, Philosophie des Unbewussten, third edition (1871): 772). Hartmann affirms that if unlike Schopenhauer one admits the reality of time and of the world process, one must also admit that the process must be limited in the past and therefore that there must be an absolute beginning. In Hartmann's mind, failure to do so would result in positing the contradictory **concept of an accomplished infinity**: "The infinity that from the point of view of regressive thinking, remains an ideal postulate, which no reality may correspond to, must, for the world, whose process is, on the contrary, a progressive movement, open up to a determinate result; and here the contradiction comes to light" (Hartmann (1871): 772). What really "comes to light" in this passage is the fact that Hartmann does not provide a demonstration but a petitio principii. Indeed, the concept of the world process analytically contains the concept of a beginning of the world. In all rigor, it is therefore impossible to demonstrate these concepts with reference to each other. Secondly, Hartmann's view that one is bound to accept the reality of the world process even if one rejects the ideality of Schopenhauer's time is mistaken. Hartmann believes that if time is real there must be a world process with both an **absolute beginning and an absolute end. Without any justification, Hartmann jumps from Schopenhauer's negated time to oriented time.** Hartmann's view is that the world process leads into a final state absolutely identical to the initial state. However, it follows from this that even as the cosmic adventures of the unconscious come to a close, we are still haunted by the specter of a new will and of another beginning of the world process. This exposes a serious internal flaw of Hartmann's system insofar as it jeopardizes the possibility of a final liberation from existence and suffering. This is why in the last pages of his work, "On the Last Principles," he painstakingly calculates the degree of probability of a reawakening of the volitional faculty of the unconscious. Insofar as the will is entirely free, unconditioned and a-temporal, the possibility of a new volition is left to pure mathematical chance and is therefore ½. Hartmann further stresses that if the will were embedded in time, the probability of the repetition would amount to 1 and the process of the world would be bound to begin again, in an eternal return which would completely preclude the possibility of a final liberation. Fortunately, this is not the case since-according to Hartmann's remarkable logic-the world-process develops through time, but the original will is outside of time. In fact, one may even affirm, along the lines of Hartmann's peculiar theory of probability, that every new beginning gradually reduces the probability of the next beginning: let n be the number of times that the will is realized, the probability of any new realization is ½ n. "But it is clear that the probability ½ n diminishes as n increases, in a way that suffices to reassure us in practice" (Hartmann (1869): 663). In his famous work entitled **On the Conservation of Force (1847), Hermann von Helmholtz** had divided the totality of the energy in the universe between potential energy and kinetic energy and affirmed the reciprocal convertibility of the two. In 1852, William Thomson pointed out that there exists a sub-ensemble within kinetic energy, heat, which, once it has been generated, is no longer entirely convertible into potential energy-or into any other form of kinetic energy. Considering that the (partial) reconversion of heat into labor is possible only in situations that present a disparity in temperature, and that heat tends to pass from warmer to cooler bodies by spreading on an even temperature level through space, Thomson concluded that the universe tends towards a final state where any energetic transformations, every movement and every form of life will cease. Caspari's atoms (which bring to mind those in Leibniz's Monadology) resemble some sort of biological monads, endowed with internal states. For Caspari, every atom obeys the ethical imperative to participate in the conservation of the general organism and its movement does not only follow the simple physical kind of interaction but also an a priori law ensuring. If a balance of forces had been attained at any moment, this moment would still be going on: therefore, it never happened. The present state contradicts this proposition. Supposing that a certain state rigorously identical with the present state had, one day, existed, this supposition is not refuted by the present state. As one of the infinite possibilities, it is necessary that the present state had been given anyway, since until now an infinite period of time has already unfolded. **If equilibrium were possible, it must have occurred**; and if the present state has already taken place, then so too the one that preceded it as well as the one preceding that one. Therefore it has already taken place a second time, a third time and so on. And likewise it shall take place again a second time, a third time. Innumerable times forwards and backwards. This amounts to saying that all becoming occurs within a repetition of an innumerable number of absolutely identical states. [.] The immovability of forces, their equilibrium is a conceivable case, but it has not occurred. As a result the number of possibilities is greater than the number of realities. -The fact that nothing identical recurs may be explained not thanks to chance, but only thanks to an intention infiltrated within the essence of force. Indeed, supposing an enormous amount of cases, the random occurrence of the same combination is more probable than the same combination never recurring. The quantum of force in the universe is determinate and not "infinite": let us beware [hüten wir uns] from such conceptual extravaganza! Therefore the number of situations, modifications, combinations and developments of this force is doubtless enormous and practically "immeasurable," but in any case this number is determinate and not infinite. On the other hand, the time in which the universe exerts its force is infinite. That is to say, that force is eternally identical and eternally active: -until the present instant infinity has already taken place, which is to say that all possible developments must have already, taken place. Consequently, the present development must be a repetition and therefore both this that was born from it and this that shall be born from it and so on both forwards and backwards. Everything has taken place an innumerable number of times because the overall situation of all forces always recurs (FP 11 [202] of 1881). Nietzsche regards the mechanistic vision as more plausible and less anthropomorphic than organicism. However, faced with the two major **cosmological models of his time, the mechanistic model and the organic model, Nietzsche wishes to return its polymorphous, proteiform, unstructured** and chaotic character to nature of which the perfectly non-theological and non-teleological theory of eternal return is the strongest seal. This is the first of the "new battles" which come to whoever is aware of the consequences of the death of God: take any antropomorphism away from nature. In the preparatory papers, the third book of the Gay Science is entitled "Gedanke eines Gottlosen / Thoughts of a Godless One." Aphorism 109 of this book, which immediately follows the famous aphorism against the shadows of God, **Boltzmann's theory belongs to the third phase of the debate on thermodynamics and cosmology. The publication of Thomson's brief paper "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy" of 1852 signals the beginning of the scientific controversies on the problem of the dissipation of energy and opened the first phase of the debate, which was announced in the Reflexions on the Motor Powers of Fire by Sadi Carnot and whose conclusion is represented by Clausius's recapitulative article on the concept of entropy in 1865.[44] The second phase started in 1867 when, at the forty-first congress of German scientists and doctors, Clausius gave a lecture on "The Second Principle of the Mechanistic Theory of Heat," where he applied the results of his research on thermodynamics to the universe**. It is true that in his famous lecture of 1854, Helmholtz had already presented the cosmic consequences of the second principle, but Clausius' contribution had a strong impact on German culture. This is because in this lecture he robustly rejected the possibility to consider the universe as an eternal and self-renewing circle, an ewiger Kreislauf in which force and matter are in constant transformation, as was heretofore affirmed by the materialism of the scientists and philosophers, and he did so in the name of the second principle of thermodynamics. In this way, the debate on the principles of thermodynamics gained great importance in European Culture starting in 1867. In the two first phases, it is Thomson's mechanism that predicts the thermal death of the universe. In the third phase, on the contrary, the meaning of the term mechanism changes radically.[46] In accordance with the apocalyptic climate of this period dominated by the "rebirth of idealism," the "overcoming of scientific materialism" and the "bankruptcy of science", the mechanistic paradigm which had accompanied the birth of modern science became challenged on **account of the second principle of thermodynamics**. According to the theorem of the quasi-periodicity of the motions of mechanical systems demonstrated by Poincaré as part of the problem of the three bodies (1890), a mechanical system must evolve according to a quasi-periodical movement and consequently it must always return-sooner or later-to the initial state. **An easily established theorem informs** us that a limited world obeying solely the laws of mechanics shall always pass through a state closely similar to its initial state. On the contrary, according to established experimental laws (supposing we grant them absolute value and wish to push their consequences to the end), the universe is directed towards a final state, which once it is attained, it shall not be able to escape. In this final state, which shall be like a sort of death, all material bodies shall be at rest at the same temperature. **Poincaré's theorem seems** therefore incompatible with the second principle of thermodynamics, which predicts a unidirectional movement of all natural phenomena until the whole universe is brought to a total standstill. Wilhelm Ostwald and the entire energeticist school of thought contended that the principles of thermodynamics were fundamentally new, and could not be re-incorporated to traditional physics and that they should serve as a basis for a new science that regards the qualitative diversity of energy and its tendency to degradation as its axioms. Against energeticism and in an effort to bring entropic phenomena back into the theoretical framework of mechanism, Ludwig Boltzmann introduced the concept of probability in physics, not as an instrument of calculation, but as an explicative principle. In Boltzmann's statistical thermodynamics, the increase of entropy assumed by Clausius is re-interpreted as an increase in molecular chaos. As a result, it becomes possible to explain mechanistically the evolution of closed systems endowed with increasing entropic value, without it committing us to granting absolute value to the second principle of thermodynamics. **Moreover, one no longer needs to fear the thermal death of the universe insofar as the state of equilibrium will in principle** never be complete, but rather will be attained only statistically, leaving open the possibility of fluctuations towards less probable states. Boltzmann's critics remarked that this hypothesis involved two paradoxes called the objection of reversibility (Umkehreinwand), and that of repetition (Wiederkehreinwand). I shall only address here the second one since it coincides with the theory of the eternal return. Based on Poincaré's theorem quoted above, Ernst Zermelo objected to Boltzmann that his model of the universe suggested that after a finite (if admittedly very long) time the system would return to its initial position. In his first response to Zermelo, Boltzmann avoids committing himself directly to cosmological questions and he only observes that, in the case of concrete thermodynamic systems, the time of recurrence may be extremely long. For example, in normal conditions of pressure and temperature, one-centimeter cube of gas requires 1010 years to reach a molecular configuration identical to the original one! However, following a response by Zermelo, Boltzmann wrote a new article where he outlines a cosmological picture that he will re-use later in his conclusion to his famous Lectures on Gas Theory. In this cosmological picture, Boltzmann considers the universe as a closed system with constant entropy, within which some fluctuations occur, creating islands of negative entropy. Our solar system originates in one of these fluctuations. As Clausius correctly pointed out, the entropy of our solar system increases constantly as the solar system gets closer to the state of chaos and of the thermal death of the rest of the cosmos. However, in other zones of the universe, some new fluctuations and new islands appear, so that thermal death is never generalized. Here we are given a grand cosmic image, in which the solar system and the sparkle of life that was lit on planet earth are only a fluctuation of order from within a dominant entropic tendency. Life, and the order on which it is based are exceptions, transitory forms taking place in the realm of the shapeless, they are islands of the cosmos that will soon be re-absorbed into chaos. According to Poincaré's theorem, our island will have to be reborn, to develop and die innumerable times in a strictly identical fashion. This happened an infinite number of times during the past eternity and it shall take place again an infinite number of times in the eternity to come. **Boltzmann accepts the "paradox" of recurrence-that is the eternal return of the same-as a legitimate consequence of the probabilistic conception of thermodynamics**. It may be rejected for ethical reasons, it may be stored away as an abstract speculation or dismissed along with other cosmic fantasies, but it cannot be rejected on the basis of any rigorously scientific viewpoint. **The Eternal Return: Genesis and Interpretation BY PAUL D'IORIO(excerpts). Nietzsche found the template of a materialistic cosmology based upon the first principle of thermodynamics. During the same year, he could have found a model of an organistic solution to the problem of thermal death of the universe as well as a discussion on the conformation of space in Zöllner's book On the Nature of Comets** (Johann Carl Friedrich Zöllner, Über die Natur der Kometen. Beiträge zur Geschichte und Theorie der Erkenntnis (Leipzig, Engelmann, 1872), 299 f. and 313 f.); Assumed Association In Space Time Of Particles Or Men Leads To Detrimental Ramification Be In Terms Of Progress Of "Subject Matter" Or In The Pathological Disequilibrium Of Gratification Deprivation Complex Which Again Has Mental Turbulence In Case Collective Consciousness Approve It (Raaga) Or Pernicious Implications In Case The Theory Is Not Accepted; After All What Is A Theory: Set Of Correlations And Causations Which Are "Tested" Against A Collective Consciousness Background, Which Yields "Results' Which Are Themselves In "Question" Due To The Very Perception And The Simulation Prospective. The Definition Of Quantum Theorists' Terms, Such As Wavefunctions And Matrix Mechanics, Progressed Through Many Stages. For Instance, Erwin Schrödinger Originally Viewed The Electron's Wavefunction As Its Charge Density Smeared Across The Field, Whereas Max Born Reinterpreted It As The Electron's Probability

Density Distributed Across The Field. Although The Copenhagen Interpretation Was Originally Most Popular, Quantum Decoherence Has Gained Popularity. Thus The Many-Worlds Interpretation Has Been Gaining Acceptance Moreover, The Strictly Formalist Position, Shunning Interpretation, Has Been Challenged By Proposals For Falsifiable Experiments That Might One Day Distinguish Among Interpretations, As By Measuring An AI Consciousness Or Via Quantum Computing. More Or Less, All Interpretations Of Quantum Mechanics Share Two Qualities: They Interpret Formalism—A Set Of Equations And Principles To Generate Predictions Via Input Of Initial Conditions They Interpret A Phenomenology—A Set Of Observations, Including Those Obtained By Empirical Research And Those Obtained Informally, Such As Humans' Experience Of An Unequivocal World Two Qualities Vary Among Interpretations: Ontology—Claims About What Things, Such As Categories And Entities, Exist In The World Epistemology—Claims About The Possibility, Scope, And Means Toward Relevant Knowledge Of The World. Now How Does A Person In A Crowd Behave? They He Would Due To Herd Mentality; Ok; That Is One Theory; Simulation By Terrestial Brahman Anti Brahman Will Make Them Behave In A Highly Organised And Coordinated Manner; With Association Of Things And Individuals Already Established Resultant Orientation Of The Actions Hall Be Only Oriented Towards The Figment Of Imagination And Product Of Puerile Prognostication Formally Established By Terrestial Brahman Anti Brahman Before Such A Coordinated And Organised Execution Of Exercise Is Conducted; Analogically, If A Simulation Is Going On In A Bunch Of Particles Or Electrons, And If Some Agency Say Celestial Brahman Anti Brahman Agency Is Simulating It, There Shall Be Coordination And Organisation So That You See "Reality" While The Truth Shall Remain Hidden. Result Is The Suppression Of Information, Delineation Of Disinformation, And The Concomitant Development Of Mushrooms Of Concocted And Fabricated Theories To That "Reality"; In The Case Of Terrestial Brahman Anti Brahman Agency Intention May Be To Bulldoze And Bowdlerize You, Baffle And Befuddle You In To Submission; In The Case Of Celestial Brahman Anti Brahman Agency Only Reason Could Be To Shield The Truth Being Disseminated; But Why?;May Be You Should Never Become God Which You Are Trying To; May Be God Is Really Playing Dice; What Does That Result In To ; You Become A Scezophreniac Associating Again And Again What You Had Been Until Now Of Particles And Other Concomitants Again And Again Leading To Flawed Inferences. Confusing The Epistemic With The Ontic, Like If One Were To Presume That A General Law Actually "Governs" Outcomes—And That The Statement Of A Regularity Has The Role Of A Causal Mechanism—Is A Category Mistake. In A Broad Sense, Scientific Theory Can Be Viewed As (=) Offering Scientific Realism—Approximately True Description Or Explanation Of The Natural World—Or Might Be Perceived With Antirealism. A Realist Stance Seeks The Epistemic And The Ontic, Whereas An Antirealist Stance Seeks Epistemic But Not The Ontic. In The 20th Century's First Half, Antirealism Was Mainly Logical Positivism, Which Sought To Exclude Unobservable Aspects Of Reality From Scientific Theory. Since The 1950s, Antirealism Is More Modest, Usually Instrumentalism, Permitting Talk Of Unobservable Aspects, But Ultimately Discarding The Very Question Of Realism And Posing Scientific Theory As A Tool To Help Humans Make Predictions, Not To Attain Metaphysical Understanding Of The World. The Instrumentalist View Is Carried By The Famous Quote Of David Mermin, "Shut Up And Calculate", Often Misattributed To Richard Feynman. Quantum Mechanical Wave Function (Absolutely Squared) Describes The Completed Interference Pattern, It Must Describe An Ensemble Interpretations Of Quantum Mechanics From Wikipedia. Philosophy Of Science, The Distinction Of Knowledge Versus Reality Is Termed Epistemic Versus Ontic. A General Law Is A Regularity Of Outcomes (Epistemic), Whereas A Causal Mechanism May Regulate The Outcomes (Ontic). A Phenomenon Can Receive Interpretation Either Ontic Or Epistemic. For Instance, Indeterminism May Be Attributed To Limitations Of Human Observation And Perception (Epistemic), Or May Be Explained As A Real Existing Maybe Encoded In The Universe (Ontic). Confusing The Epistemic With The Ontic, Like If One Were To Presume That A General Law Actually "Governs" Outcomes—And That The Statement Of A Regularity Has The Role Of A Causal Mechanism—Is A Category Mistake. Interpretations Of Quantum Mechanics From Wikipedia. Reality Is Constant In The Midst Of Change. Note The Conservation Of Individual, Collective And Cosmic General Ledgers Are What Are Being Spoken Of. Not The Changing Transactions, But The Immutable Refractory Zero. (Italics Mine) What This Means Essentially Is That There Is Change Although Nothing Changes. Like There Are Changing Transactions And Still The Assets And Liabilities

Will Be Equal. This Impossible Situation Is Reflected (E&Eb) In The Ultimate Impossibility Of Change Itself. That Which Does Not Exist Prior To Its Changing And At The End, After It Has Changed, Must Be Equally Non-Existent Between These Two Moments. Although The World Of Change Appears To Be Real, It Cannot Be So. (Real)Change, According To The Vedantin, Presupposes A Loss Of Identity. Reality Cannot Suffer Transformation If It Were To Do So, It Would Become Something Else And The Real Would Be Deprived Of Its Reality. The Immortal Can Never Become Mortal, Nor Can The Mortal Become Immortal The Doctrine Of Vibration: An Analysis Of The Doctrines And Practices Of Kashmir Shaivism Mark S. G. Dyczkowski. Concept Of Being From Shaivite Point Of View: In His Famous Work Entitled On The Conservation Of Force (1847), Hermann Von Helmholtz Had Divided The Totality Of The Energy In The Universe Between Potential Energy And Kinetic Energy And Affirmed The Reciprocal Convertibility Of The Two. In 1852, William Thomson Pointed Out That There Exists A Sub-Ensemble Within Kinetic Energy, Heat, Which, Once It Has Been Generated, Is No Longer Entirely Convertible Into Potential Energy-Or Into Any Other Form Of Kinetic Energy. Considering That The (Partial) Reconversion Of Heat Into Labor Is Possible Only In Situations That Present A Disparity In Temperature, And That Heat Tends To Pass From Warmer To Cooler Bodies By Spreading On An Even Temperature Level Through Space, Thomson Concluded That The Universe Tends Towards A Final State Where Any Energetic Transformations, Every Movement And Every Form Of Life Will Cease: The Eternal Return: Genesis And Interpretation BY PAUL D'IORIO: The Ultimate Nature Of Anything Cannot Change. Change Of Any Sort Is Merely Apparent (Vivarta). The World Of Change And Becoming Is A False Super- Imposition (Adhyaropa, Adhyasa) On The Absolute. It Appears So On The Screen Of Individual, Collective Consciousness, Albeit One Cannot Be So Sure Of Cosmic, For There Are Many Reasons That Cosmic Transactions Also Had To Be Subjected To Change By ParaBrahaman. In Cosmic Terms, The Mistake (Bhranti) Consists Of The Supposition That The Real Brahman Is The Unreal Universe And The Unreal Universe Is The Real Brahman. In Microcosmic Terms, It Is The Mistake Of Falsely Conceiving The Body, Mind Or Even One's Personality To Be The Self. Note We Have Taken Self As Witness Consciousness. Notwithstanding There Is Nothing Wrong In The Conception Of Self As A Dynamical Presupposition, In That Individual Consciousness And Collective Consciousness And Even Cosmic Consciousness Evolutes In To ParaBrahaman. In The Same Way As The Image Of A Snake Is Falsely Superimposed On A Rope, Similarly The Universe Is Falsely Projected Onto The Real Substratum, The Brahman. Ignorance Is Not Merely A Personal Lack Of Knowledge, But A Cosmic Principle. As Such It Is Called "Maya," The Indefinable Factor (Anirvacaniya) That Brings This Mistake In Identity About. The Reality Status Of This Cosmic Illusion Is Also Indefinable: On The One Hand It Is Not Brahman, The Sole Reality; On The Other Hand It Is Not Absolutely Non-Existent Like A Hare's Horn Or The Son Of A Barren Woman. Note Here The Vedantin Avoids Talking About Zero Which We Have Avidly And Assiduously Stressed About. Nothing Is The Factor That Exists. Also See the Remarks about Satre's Being And Nothingness. Brahman Is The Source Of World Appearances Only In The Sense Of Being Their Unconditioned Ground Or Essential Nature. The Universe Is False Not Because It Has No Nature Of Its Own But Because It Does Have One. The Doctrine Of Vibration: An Analysis Of The Doctrines And Practices Of Kashmir Shaivism Mark S. G. Dyczkowski. Concept Of Being From Shaivite Point Of View: It Is The 'I Am The Body/Mind' Belief That Gives Rise To The 'I Am Not The World' Belief. These Two Beliefs Are (=) Co-Created."Consciousness Projects The Appearance Of The Mind, Body And World By Taking (Eb) The Shape Of Thinking, Sensing And Perceiving.""Attention Is Consciousness With An Object. When The Object Vanishes, Attention Simply Remains What It Always Is Consciousness.""There Is No Purpose To Meditation. The Purpose Is Already Accomplished.""Everything That Is Experienced Is Experienced By, Through, In And As Consciousness.""The Seen Cannot Be Separated From Seeing And Seeing Cannot Be Separated From Consciousness." "**The Reality Of Any Experience Is Not Hidden In The Appearance; It Is Expressed By The Appearance The Transparency Of Things**' By Rupert Spira Book Review By Dennis Waite The Following Is A Review Of Rupert's Book: 'The Transparency Of Things: Contemplating The Nature Of Experience'. There Is An Essay From The Book Here And The Essay On Cézanne May Be Read At The Awakened Eye Website Nature Rejects The Naiveté That Seeks Absolute Truth. We Are Beginning To Realize, Individually And Culturally, That "Realities" Are All Human Constructions. The Task Becomes One Of "Catching Ourselves In The Act" Of Creating

Our Own "Reality" From The Flow Of Events. Human Truth Is Always An Engagement Of Mind With Experience. The Challenge Of The Therapist In These Times Of Chaotic Change Is To Validate The Concept That We Don't Have To Fear The Collapse Of What We Think We Are. Strange Attractors: Transference, Holography, And An **Archetype Burke, J. (2003). Strange Attractors: Transference, Holography, And An Archetype (Doctoral Dissertation, Pacifica Graduate Institute, 2003).** When we get to the topic and understanding of the Transcendental Logic, the brilliant and baffling Transcendental Deduction (TD) Recall the two movements just discussed, the one from experience to its conditions and the one from the forms of valid inference to the concepts that we must use in all judging (the Categories). This duality led Kant to his famous question of right (quid juris) (A84=B116): with what right do we apply the Categories, which are not acquired from experience, to the contents of experience? (A85=B117). Kant's problem here is not as arcane as it might seem. It reflects an important question: How is it that the world as we experience it conforms to our logic? In briefest form, Kant thought that the trick to showing how it is possible for the Categories to apply to experience is to show that it is necessary that they apply (A97).TD has two sides, though Kant never treats them separately John Marlado, accounts, attributes, and ascribes the philosophy of Nishida KitarÅ is lucid, insightful, and deeply informative despite the highly questionable argument that gives the book its structure. In comparison with other, technically more accurate accounts of Nishida's philosophy, it is broader in scope than most but more single-minded in its approach. The analysis is for the most part limited to four books that have been translated into English, out of approximately 16 volumes of philosophical essays in Japanese, but it aims to capture the contours and most important details of Nishida's entire philosophy. To appreciate the achievement of this account, one would need only to read, in English translation or in the Japanese original, any of the volumes with their streams of repetitive, puzzling expressions and circuitous, often dead- end argumentation. Wilkinson's elucidation of details in the passages he samples makes it easier to understand why Nishida is considered Japan's greatest academic philosopher. A critical look at the frame of the book and some of its own claims reveals where, to my mind, it has gone astray. The argument that frames this book is repeated throughout: Nishida's philosophy is an attempt to articulate, in a characteristically Western philosophical manner, the Zen experience he had as a young man. Nishida first made the attempt by using the conceptual frameworks of Western philosophers, and after they failed him he developed his own, largely by recasting Buddhist insights. In the end, a philosophical articulation of the Zen worldview in Western terms or even in Eastern terms recast by conceptual, Western philosophical methods approved impossible. What Nishida attempted is incommensurable with Western philosophy. While the author first offers these statements as hypotheses (p. 2), one premise of his argument that there is such a thing as "the Zen world-view" or "the Zen experience “remains unquestioned; and another that Nishida's pivotal experience was the Zen experienceâis asserted as "beyond question" (p. 151; see also pp. 28, 48, 10, 114).Wilkinson's presentation of Zen in the first chapter is drawn largely from D. T. Suzuki, with help from Suzuki's portage Abe Masao; some comments on time, birth, and death in; and a few other sources. The result is a caricature that imagines Zen as an invariable, unitary experience. In fact, Dagan’s teachings on practice as the manifestation of enlightenment do not sit well with D. T. Suzuki's emphasis on a satori experience, and Suzuki does not enlighten us about what Zen in its various practices has historically been. The author would have benefited from acquaintance with other presentations by Zen teachers, such as that of ShunryÅ Suzuki'sZen Mind Beginner's Mind, with historical accounts of Zen traditions, and with contrasts between DÅgen's view of time and Sam Â· sÄraand that of other Buddhist philosophers. A little research in contemporary Zen scholarship would have shown how implausible is the talk of "nirvana or awareness of mu" (p. 24), "the basic Zen position [that] never varies" (p. 3), "the Zen vision" (pp. 5, 7), "Zen epistemology" , "Zen experience" (p. 59), "the conception of time involved in Zen" (p. 15), and "the fundamental Zen assertion that there is no absolute time" (p. 16). Even if DÅgen's notion that time and being are nondual (p. 16) epitomized most of Zen, Nishida's early notion of "a transcendent, unchanging reality apart from time" (p. 51) would contrast sharply with it. Equally questionable is Wilkinson's contention that Nishida's "pure experience" is equivalent to Zen satori. The notion of pure experience Nishida developed in his first major work may be pivotal for his entire philosophy, but he never claims or implies that any part of his philosophy presupposes an exceptional experience like satori that grounds his convictions and renders them unverifiable to those who have not had the experience, as Wilkinson intimates (pp. 55, 159, and 161). Nishida presents his notions of pure experience and intellectual intuition, the grasp of its unity, and later... Perennialism and Constructivism is studied by Randolph T Dible : experiencer or the observer and the transcendental subjectivity itself Pure objectivity is essentially a deconstruction, apophatic and negativa The encountering of the experiencer or observer—transcendental subjectivity itself—at the foundation of the world leads inevitably to the recognition of pure objectivity as ultimate reality (which can be taken as its ultimate deconstruction, analogous to the apophatic or via negativa), from which objects derive their value, weight, significance, meaning or objectivity. In this way, pure objectivity can be seen as the supra-self-evident Axiological Axiom, so to speak, even Unconditional Love, in romantic terms. This axiology (value theory) has a structure inverse to the relationship between transcendental subjectivity as the radical unity of pure self-reference and on the other hand, the world of forms, as mere traces (representations, indications) of the unique, original "first distinction" Spencer-Brown speaks of at the foundation of his calculus. That is, all forms (i.e., distinctions, differences) would reduce to being the first distinction, also known as the marked state, which can be called penultimate reality (pure self-reference or transcendental subjectivity: the Spirit which animates us), except that forms are complimentary to their content, which is their objectivity or value, which would reduce to the unmarked state or ultimate reality. It is the incongruity of form (thoughts; Whitehead's "negative prehensions") and value (feelings; Whitehead's "positive prehensions," or my notion of objectivity, meaning and qualia; in short, the non-formal aspects of experience) that holds forms open and keeps them from absolute reduction. This accounts for the brute, concrete persistence of the "functional illusion"-- to use a term from Dzogchen Buddhism-- of the world. Thus this system has an axiology of metaphysical objectivity grounded on the ideal of pure objectivity as the source of all value, meaning and significance, itself the very fecundity of profundity, which is the motive of drawing the distinction in the first place **(Wikipedia, Kant's writings and Logic Of Sense)** Nano rings were created by accident while intending to make quantum dots. They have interesting optical properties associated with excitons and the Aharonov–Bohm effect. Application of these rings used as light capacitors or a buffer includes photonic computing and communications technology. Analysis and measurement of geometric phases in mesoscopic rings is ongoing. Several experiments, including some reported in 2012, show Aharonov-Bohm oscillations in charge density wave (CDW) current versus magnetic flux, of dominant period h/2e through CDW rings up to 85 **µm** in circumference above 77 K. This behavior is similar to that of the superconducting quantum interference devices (seeSQUID). **Aharonov–Bohm nano rings (Wikipedia) Stability analysis of nano rings would help progressively accentuate the research about the materials division that uses nano rings.** From the profound contemplation and wisdom of the Buddha and Mahabodhisattvas, we know there is no such reality. Instead, egolessness (non-self) is the only path to understand the reality of the deluded life. All existences are subject to the law of causes and conditions. These include the smallest particles, the relationship between the particles, the planets, and the relationship between them, up to and including the whole universe! From the smallest particles to the biggest matter, there exists no absolute independent identity. Egolessness (non-self) implies the void characteristics of all existence. Egolessness (non-self) signifies the non-existence of permanent identity for self and existence (dharma). Sunyata stresses the voidness characteristic of self and existence (dharma). Sunyata and egolessness possess similar attributes. As we have discussed before, we can observe the profound significance of sunyata from the perspective of inter-dependent relationships. Considering dharma-nature and the condition of nirvana, all existences are immaterial and of a void-nature. Then we see each existence as independent of each other. But then we cannot find any material that does exist independent of everything else. So egolessness also implies void-nature! From the observation of all existences, we can infer the theory of nirvana and the complete cessation of all phenomena. From the viewpoint of phenomena, all existences are so different from each other, that they may contradict each other. They are so chaotic. In reality, their existence is illusionary and arises from conditional causation. They seem to exist on one hand, and yet do not exist on the other. They seem to be united, but yet they are so different to one another. They seem to exist and yet they do cease! Ultimately everything will return to harmony and complete calmness. This is the nature of all existence. It is the final resting place for all. If we can understand this reality and remove our illusions, we can find this state of harmony and complete calmness. **Teachings in Chinese Buddhism (6) sunyata (emptiness) in the Mahayana context (Wikipedia) Many models have been given concatenating Buddhist doctrines and Vaccum energy. These models essentially throw light**

on the essence of self(witness consciousness) and the cosmic general ledger (cosmic consciousness) while the imbalance in the gratification deprivation complex always remain unbalanced when it comes to individual general ledger , advocating the evolutionary theory of individual consciousness to cosmic consciousness. It is to be noted that it is not the question of knowing all the transactions but the wisdom of what lies behind the debit- Credit, Debit-Debit, or Credit-Credit principle that is most important for assimilation. Look at this simple thesis to prove the point stated in the foregoing. Thesis: 'The World Has A Beginning In Time, And In Space It Is Also Enclosed In Boundaries.' Proof: 'For If One Assumes That The World Has No Beginning In Time, Then Up To Every Given Moment In Time An Eternity Is Elapsed, And Hence An Infinite Series Of States Of Things In The World, Each Following Another, Has Passed Away. But Now The Infinity Of A Series Consists Precisely In The Fact That It Can Never Be Completed Through A Successive Synthesis. Therefore An Infinitely Elapsed World-Series Is Impossible, So A Beginning Of The World Is A Necessary Condition Of Its Existence, Which Was The First Point To Be Proved (Kant, Critique Of Pure Reason, Tr. By R. Guyer And A. W. Wood (Cambridge: Cambridge University Press, 1998): B 454, P. 470). As Quoted In The Eternal Return: Genesis And Interpretation BY PAUL D'IORIO"The Cyclical Hypothesis, So Heavily Criticized By Nietzsche (VP II 325 And 334), Arises In This Way." In Fact, Nietzsche Was Not Criticizing The Cyclical Hypothesis But Only The Particular Form Of That Hypothesis Presented In Vogt's Work. All Of Nietzsche's Texts Without Exception Speak Of The Eternal Return As The Repetition Of The Same Events Within A Cycle Which Repeats Itself Eternally. If Deleuze's Interpretation Holds That The Eternal Return Is Not A Circle, Then What Is It? A Wheel Moving Centrifugally, Operating A "Creative Selection," "Nietzsche's Secret Is That The Eternal Return Is Selective" Says Deleuze: The Eternal Return Produces Becoming-Active. It Is Sufficient To Relate The Will To Nothingness To The Eternal Return In Order To Realize That Reactive Forces Do Not Return. However Far They Go, However Deep The Becoming-Reactive Of Forces, Reactive Forces Will Not Return. The Small, Petty, Reactive Man Will Not Return. Affirmation Alone Returns, This That Can Be Affirmed Alone Returns, Joy Alone Returns. Everything That Can Be Denied, Everything That Is Negation, Is Expelled Due To The Very Movement Of The Eternal Return. We Were Entitled To Dread That The Combinations Of Nihilism And Reactivity Would Eternally Return Too. The Eternal Return Must Be Compared To A Wheel; Yet, The Movement Of The Wheel Is Endowed With Centrifugal Powers That Drive Away The Entire Negative. Because Being Imposes Itself On Becoming, It Expels From Itself Everything That Contradicts Affirmation, All Forms Of Nihilism And Reactivity: Bad Conscience, Ressentiment..., We Shall Witness Them Only Once. [...] The Eternal Return Is The Repetition, But The Repetition That Selects, The Repetition That Saves. Here Is The Marvelous Secret Of A Selective And Liberating Repetition. There Is No Need To Remind The Reader That Neither The Image Of A Centrifugal Movement Nor The Concept Of A Negativity-Rejecting Repetition Appears Anywhere In Nietzsche's Writings, And Indeed Deleuze Does Not Refer To Any Text In Support Of This Interpretation. Further, One Could Highlight That Nietzsche Never Formulates The Opposition Between Active And Reactive Forces, Which Constitutes The Broader Framework Of Deleuze's Interpretation. For Some Years, Marco Brusotti Has Called Attention To The Fact That Deleuze Introduced A Dualism That Does Not Exist In Nietzsche's Writings. To Be Sure, The German Philosopher Describes A Certain Number Of "Reactive" Phenomena (For Example, In The Second Essay Of The Genealogy Of Morality, § 11, He Talks About "Reactive Affects" [Reaktive Affekte], "Reactive Feelings" [Reaktive Gefühlen], Reactive Men [Reaktive Menschen]); But These Are Nonetheless The Result Of Complex Ensembles Of Configurations Of Centers Of Forces That Remain In Themselves Active. Neither The Word Nor The Concept Of "Reactive Forces" Ever Appears In Nietzsche's Philosophy. The Eternal Return: Genesis And Interpretation BY PAUL D'IORIO Some Parts Are Deleted Due To Spatial Constraints. In the midst of thoughts about the eternal return we find at least two other thematic axes On the one hand, the view of the **world as a constant flux of forces without any goal, law, or rules of becoming. A chaos sive natura de-divinized and de-anthropomorphized which constitutes the "ontological substratum**" of the whole of Nietzsche's reflexions On the other hand, an ensemble of fragments of an anthropologico-sociological character, designing a path of liberation leading to the creation of superior individuals by way of a profound transformation of their instinctual structure. This transformation must be achieved by a practice of solitude and internal struggle towards the liberation from the ancient representations of the world and from the incorporated herd values. For an analysis of these thematic perspectives, see Paolo D'Iorio, La linea e il circolo. Cosmologia e filosofia dell'eterno ritorno in Nietzsche (Genova: Pantograf, 1995): 233-322. With most of the parameters quantified, with assumptions there must be picturesque view of the self and non self, space and time, science and philosophy with the concatenational consummations. After The Chapter "On Redemption," Where Zarathustra Dares Not Expose His Doctrine, The Eternal Return Begins To Be Enunciated In Part Three Of The Work. In The First Place, It Is The Dwarf Who Formulates It In The Chapter "On The Vision And The Riddle." Facing The "Gate Of The Instant" Which Symbolizes The Two Infinities That Stretch Towards The Past And The Future, The Dwarf Whispers: "All Truth Is Crooked, Time Itself Is A Circle" The Dwarf Represents The Spirit Of Gravity, And He Embodies The Herd Morality, "The Belittling Virtue" Which Is The Title Of Another Chapter From Part III. The Dwarf Can Endure The Eternal Return Without Great Difficulties Because He Has No Aspirations; Unlike Zarathustra He Does Not Wish To Climb The Mountains That Symbolize Elevation And Solitude. In Two Unpublished Notes, From The Summer And The Fall Of 1883, Nietzsche Writes: The Doctrine Is At First Favored By The Rabble, Before It Gets To The Superior Men. The Doctrine Of Recurrence Will First Smile To The Rabble, Which Is Cold And Without Any Strong Internal Need. It Is The Most Ordinary Of Life Instincts, Which Gives Its Agreement First. Hence, The Content Of The Doctrine Is The Same, But Whereas The Dwarf Can Endure It (Because He Interprets It According To The Pessimistic Tradition For Which "Nothing Is New Under The Sun"), Zarathustra, Who Is The "Advocate Of Life" Regards The Eternal Return As The Strongest Objection To Existence, And As The Rest Of The Dream Suggests, He Does Not Yet Succeed In Accepting It After The Vision At The Gate Of The Instant, The Chapter Is Brought To An End By The Enigma Of The Shepherd. The Eternal Return: Genesis And Interpretation BY PAUL D'IORIO .How does the memory affect the GD complex or for that matter the gratification deprivation of an individual or a collective identity? Non-Markovian local-in-time master equations give a relatively simple way to describe the dynamics of open quantum systems with memory effects. Despite their simple form, there are still many misunderstandings related to the physical applicability and interpretation of these equations. Here, we clarify these issues both in the cases of quantum and classical master equations. Further introduction of the concept of a classical non-Markov chain signified through negative jump rates in the chain configuration. **E-M Laine et al 2012 J. Phys. B: At. Mol. Opt. Phys. 45 154004 doi:10.1088/0953-4075/45/15/154004 Local-in-time master equations with memory effects: applicability and interpretation.** Supposing That There Were Indeed An "Energy Of Contraction" Constant In All Centers Of Force Of The Universe, It Remains To Be Explained Where Any Difference Would Ever Originate. It Would Be Necessary For The Whole To Dissolve Into An Infinite Number Of Perfectly Identical Existential Rings And Spheres, And We Would Therefore Behold Innumerable And Perfectly Identical Worlds COEXISTING [Nietzsche Underlines This Word Twice] Alongside Each Other. Is It Necessary For Me To Admit This? Is It Necessary To Posit An Eternal Coexistence On Top Of The Eternal Succession Of Identical Worlds? The Eternal Return: Genesis And Interpretation BY PAUL D'IORIO. Science is usually portrayed as dehumanizing. Brave New World epitomizes this fear. "The more we understand the world, the more it seems completely pointless" (Steven Weinberg). Certainly science can seem chilling when conceived in the abstract as a metaphysical world-picture. We may seem to find ourselves living in a universe with all the human meaning stripped out: Participants in a soulless dance of molecules, or harmonics of pointlessly waggling superstrings and their braneworld cousins. Nature seems loveless and indifferent to our lives. What rights have we to be happy? **(Brave New World: Aldous Huxley).** Religion can afford to be dogmatic but science cannot. Look at this passage which counters both scientists and philosophers alike: However, Hartmann Objects That The Regressive Movement Postulated By Schopenhauer Is Possible Only In Thought: It Remains Nothing More Than An "Ideal Postulate" With No Real Object And Which "Does Not Teach Us Anything About The Real Process Of The World That Unfolds In A Movement Contrary To This Backwards Movement Of Thought" (Hartmann, Philosophie Des Unbewussten, Third Edition (1871): 772). Hartmann Affirms That If Unlike Schopenhauer One Admits The Reality Of Time And Of The World Process, One Must Also Admit That The Process Must Be Limited In The Past And Therefore That There Must Be An Absolute Beginning. In Hartmann's Mind, Failure To Do So Would Result In Positing The Contradictory Concept Of An Accomplished Infinity: "The Infinity That From The Point Of View Of Regressive Thinking, Remains An Ideal Postulate, Which No Reality May Correspond To, Must, For The World, Whose Process Is, On The Contrary, A Progressive Movement, Open Up To A Determinate Result; And Here The Contradiction Comes To Light" (Hartmann (1871): 772). What Really "Comes To Light" In This Passage Is The Fact That Hartmann Does Not Provide A Demonstration But A Petitio Principii. Indeed, The Concept Of The World Process Analytically Contains The Concept Of A Beginning Of The World. In All Rigors, It Is Therefore Impossible To Demonstrate These Concepts With Reference To Each Other. Secondly, Hartmann's View That One Is Bound To Accept The Reality Of The World Process Even If One Rejects The Ideality Of Schopenhauer's Time Is Mistaken. Hartmann Believes That If Time Is Real There Must Be A World Process With Both An Absolute Beginning And An Absolute End. Without Any Justification, Hartmann Jumps From Schopenhauer's Negated Time To Oriented Time. The Eternal Return: Genesis And Interpretation BY PAUL D'IORIO. In the last years several theoretical papers discussed if time can be an emergent property deriving from) quantum correlations. Here, to provide an insight into how this phenomenon can occur, authors present an experiment that illustrates Page and Wootters' mechanism of "static" time, and Gambini et al. subsequent refinements. A static, entangled state between a clock system and the rest of the universe is perceived as evolving by internal observers that test the correlations between the two subsystems. They implement this mechanism using an entangled state of the polarization of two photons, one of which is used as a clock to gauge the evolution of the second: an "internal" observer that becomes correlated with the clock photon sees the other system evolve, while an "external" observer that only observes global properties of the two photons can prove it is static.Phys. Rev. A 89, 052122 (2014)DOI:10.1103/PhysRevA.89.052122 arXiv: 1310.4691 [quant-ph] **Time from quantum entanglement: an experimental illustration Ekaterina Moreva.** Time is an entanglement .When the new ideas of quantum mechanics spread through science like wildfire in the first half of the 20th century, one of the first things physicists did was to apply them to gravity and general relativity. The results were not pretty. It immediately became clear that these two foundations of modern physics were entirely incompatible. When physicists attempted to meld the approaches, the resulting equations were bedeviled with infinities making it impossible to make sense of the results. Then in the mid-1960s, there was a breakthrough. The physicists John Wheeler and Bryce DeWitt successfully combined the previously incompatible ideas in a key result that has since become known as the Wheeler-DeWitt equation. This is important because it avoids the troublesome infinites—a huge advance. But it didn't take physicists long to realise that while the Wheeler-DeWitt equation solved one significant problem, it introduced another. The new problem was that time played no role in this equation. In effect, it says that nothing ever happens in the universe, a prediction that is clearly at odds with the observational evidence. This conundrum, which physicists call 'the problem of time', has proved to be thorn in flesh of modern physicists, who have tried to ignore it but with little success. Then in 1983, the theorists Don Page and William Wootters came up with a novel solution based on the quantum phenomenon of entanglement. This is the exotic property in which two quantum particles share the same existence, even though they are physically separated. Entanglement is a deep and powerful link and Page and Wootters showed how it can be used (e) to measure time. Their idea was that the way pair of entangled particles evolves is a kind of clock that can be used to measure change. But the results depend on how the observation is made. One way to do this is to compare the change in the entangled particles with an external clock that is entirely independent of the universe. This is equivalent to god-like observer outside the universe measuring the evolution of the particles using an external clock. In this case, Page and Wootters showed that the particles would appear entirely unchanging—that time would not exist in this scenario. But there is another way to do it that gives a different result. This is for an observer inside the universe to compare the evolution of the particles with the rest of the universe. In this case, the internal observer would see a change and this difference in the evolution of entangled particles compared with everything else is an important a measure of time. This is an elegant and powerful idea. It suggests that time is an emergent phenomenon that comes about because of the nature of entanglement. And it exists only for observers inside the universe. **Time is an entanglement** (Wikipedia). Danish religious philosopher Soren Kierkegaard carried out a systematic critique of the pretensions of reason and an abstract rationalism which he believed that the modern age was nurturing. Condemning reflection as a "danger" that ensnares people in logical delays and machinations, Kierkegaard compared it to a prison. Reflection is for him a form of captivity, a bondage which "can only be broken by [passionate] religious inwardness" (1978: 81). **Reflection seduces individuals into thinking its possibilities are "much more magnificent than a paltry**

decision" (1978: 82). It leads them to act **"on principle,"** to dwell on the deliberation of the context of their actions and the calculation of their worth or outcome. Kierkegaard argues that this drives away feeling, inspiration, and spontaneity, all of which are crucial for true inner being and a vital relation to God. For Kierkegaard, as Nietzsche would later agree, genuine inner being (and culture) is characterized by the tautness and tension of the soul which characterizes passionate existence. But the "coiled springs of life relationships ... lose their resilience" in reflection (1978: 78) and "everything becomes meaningless externality, devoid of [internal] character" (1978: 62). Kierkegaard thus contributes to the development of an irrationalist tradition that has echoes in some later postmodern thought. Kierkegaard might well have agreed with his contemporary Fyodor Dostoyevsky, who wrote: "An intelligent [reflective] man cannot seriously become anything ... excessive consciousness is a disease" (1974: 3, 5). In an age overtaken by rules and regulations, genuine action -- which Kierkegaard assumes to be subjective and spontaneous -- is frustrated at every turn. Complaining that we are too "sober and serious" (1978: 71) even at banquets, Kierkegaard bemoans the fact that even suicides are premeditated (1978: 68)! "That a person stands or falls on his actions is becoming obsolete; instead, everybody sits around and does a brilliant job of bungling through with the aid of some reflection and also by declaring that they all know very well what has to be done" (1978: 73). Thus, it is passion, not reflection, that guarantees "a decent modesty between man and man [and] prevents crude aggressiveness" (1978: 62). "Take away the passion and the propriety also disappears" (1978: 64). The ambiguity in the word "passion" may cause some confusion here. To say that the age and its individuals are "passionless" is not to say there are no emotions whatsoever, but rather that there is no true spiritual inwardness and depth, no intensively motivated action and commitment. It suggests that passion exists only in a simulated, pseudo-form, "the rebirth of passion" through "talkativeness" (1978: 64). "Chattering" for Kierkegaard gets in the way of "essential speaking" and merely "reflects" inconsequential events (1978: 89-99). Hence, in “the present age,” emotions -- which in fact are all too pronounced -- have been transformed into negative forces. Anticipating Nietzsche's genealogy of the "slave revolt" in morality, Kierkegaard claims that the "enthusiasm" of the prior age of Revolution, a "positively unifying principle,” has become a vicious "envy," a "negatively unifying principle" (1978: 81), a leveling force in its own right insofar as those lacking in talent and resources want to tear down those who have them. **THE POSTMODERN TURN IN PHILOSOPHY: THEORETICAL PROVOCATIONS AND NORMATIVE DEFICITS By Steven Best and Douglas Kelner http://www.gseis.ucla.edu/faculty/kellner/kellner.html.** In November 2011, the United States government argued before the US Supreme Court that it wants to continue utilizing GPS tracking of individuals without first seeking a warrant. In response, Justice Stephen Breyer questioned what this means for a democratic society by referencing Nineteen Eighty-Four. Justice Breyer asked, "If you win this case, then there is nothing to prevent the police or the government from monitoring 24 hours a day the public movement of every citizen of the United States. So if you win, you suddenly produce what sounds like 1984... "[65]. What is to be said in unmistakable terms is that when it comes to national security and innocent citizens there is question of compromise even it be an infringement and encroachment of so called privacy which has been made a word to subterfuge the activities that are far said to be fair. Quantum theory has provoked intense discussions about its interpretation since its pioneer days. One of the few scientists who have been continuously engaged in this development from both physical and philosophical perspectives is Carl Friedrich von Weizsäcker. The questions he posed were and are inspiring for many, including the authors of this contribution. Weizsäcker developed Bohr’s view of quantum theory as a theory of knowledge. **Harald Atmanspacher, Hans Primas** show that such an epistemic perspective can be consistently complemented by Einstein’s ontically oriented position. **Time, Quantum and Information 2003, pp 301-321 Epistemic and Ontic Quantum Realities Harald Atmanspacher, Hans Primas Robert W. Spekkens** present a toy theory that is based on a simple principle: the number of questions about the physical state of a system that are answered must always be equal to the number that are unanswered in a state of maximal knowledge. Many quantum phenomena are found to have analogues within this toy theory. These include the noncommutativity of measurements, interference, the multiplicity of convex decompositions of a mixed state, the impossibility of discriminating nonorthogonal states, the impossibility of a universal state inverter, the distinction between bipartite and tripartite entanglement, the monogamy of pure entanglement, no cloning, no broadcasting, remote steering, teleportation, entanglement swapping, dense coding, mutually unbiased bases, and many others. The diversity and quality of these analogies is taken as evidence for the view that quantum states are states of **incomplete knowledge** rather than states of reality. A consideration of the phenomena that the toy theory **fails to reproduce, notably, violations of Bell inequalities** and the existence of a Kochen-Specker theorem, provides clues for how to proceed with this research program.DOI: http://dx.doi.org/10.1103/PhysRevA.75.032110 **Evidence for the epistemic view of quantum states A toy theory Phys Rev A 75, 032110 – Published 19 March 2007 Robert W. Spekkens In such specialized and autonomous areas, it is to the eminent and erudite authors to interpret the contradistinctions and contradictions' in the dove tailing explaining. This I feel would be yeoman service in the creation of Nature's general ledger. M. S. Leifer and O. J. E. Maroney** examine the relationship between quantum contextuality (in both the standard Kochen-Specker sense and in the generalized sense proposed by Spekkens) and models of quantum theory in which the quantum state is maximally epistemic. We find that preparation noncontextual models must be maximally epistemic, and these in turn must be Kochen-Specker noncontextual. This implies that the Kochen-Specker theorem is sufficient to establish both the impossibility of maximally epistemic models and the impossibility of preparation noncontextual models. The implication from preparation noncontextual to maximally epistemic then also yields a proof of Bell's theorem from an Einstein-Podolsky-Rosen-like argument. DOI: http://dx.doi.org/10.1103/PhysRevLett.110.120401 Received 25 August 2012Published 20 March 2013 © 2013 American Physical Society **Maximally Epistemic Interpretations of the Quantum State and Contextuality Phys. Rev. Lett 110, 120401 – Published 20 March 2013 M. S. Leifer and O. J. E. Maroney.** Epistemological, onitic and ontological aspects particularly of quantum mechanics have invited profound thinkers to contribute their mite to the growing literature on the subject, which includes the contributions from the subterranean realm and ceratoid dualism of philosophy like that Chaos theory of Deleuze, Derrida , Kierkegaard and others. **Andrei Khrennikov** shows that the Dirac-von Neumann formalism for quantum mechanics can be obtained as an approximation of classical statistical field theory. This approximation is based on the Taylor expansion (up to terms of the second order) of classical physical variables – maps f: $\Omega \rightarrow R$, where Ω is the infinite-dimensional Hilbert space. The space of classical statistical states consists of Gaussian measures ρ on Ω having zero mean value and dispersion $\sigma 2$ (ρ) $\approx$ h. This viewpoint to the conventional quantum formalism gives the possibility to create generalized quantum formalisms based on expansions of classical physical variables in the Taylor series up to terms of nth order and considering statistical states ρ having dispersion $\sigma 2(\rho)$ = h n (for n = 2 we obtain the conventional quantum formalism). **December 2005, Volume 18, Issue 7, pp 637-650 Date: 28 Nov 2005 Generalizations of Quantum Mechanics Induced by Classical Statistical Field Theory Andrei Khrennikov** It is widely accepted that consciousness or, in other words, mental activity is in some way correlated to the behavior of the brain or, in other words, material brain activity. Since quantum theory is the most fundamental theory of matter that is currently available, it is a legitimate question to ask whether quantum theory can help us to understand consciousness. Several approaches answering this question affirmatively, proposed in recent decades, will be surveyed. It will be pointed out that they make different epistemological assumptions, refer to different neurophysiological levels of description, and adopt quantum theory in different ways. For each of the approaches discussed, these imply both problematic and promising features which will be indicated. **Discrete Dynamics in Nature and Society Volume 2004 (2004), Issue 1, Pages 51-73 http://dx.doi.org/10.1155/S102602260440106X Quantum theory and consciousness: an overview with selected examples Harald Atmanspacher Copyright © 2004 Hindawi Publishing Corporation. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.** Another thought provoking and investigatory article is by Peter G. Lewis et al. Perhaps the quantum state represents information about reality, and not reality directly. Wave function collapse is then possibly no more mysterious than a Bayesian update of a probability distribution given new data. **Peter G. Lewis et al** consider models for quantum systems with measurement outcomes determined by an underlying physical state of the system but where several quantum states are consistent with a single underlying state—i.e., probability distributions for distinct quantum states overlap. Significantly, they demonstrate by example that additional assumptions are always necessary to rule out such a model. DOI: http://dx.doi.org/10.1103/PhysRevLett.109.150404 **Distinct Quantum States Can Be Compatible with a Single**

State of Reality Phys. Rev. Lett. 109, 150404 – Published 9 October 2012 Peter G. Lewis et al Communication complexity of a quantum channel is the minimal amount of classical communication required for classically simulating a process of state preparation, transmission through the channel and subsequent measurement. It establishes and perpetuates a limit on the power of quantum communication in terms of classical resources. **Alberto Montina** shows that classical simulations employing a finite amount of communication can be derived from a special class of hidden variable theories where quantum states represent statistical knowledge about the classical state and not an element of reality. This special class has attracted strong interest very recently. The communication cost of each derived simulation is given by the mutual information between the quantum state and the classical state of the parent hidden variable theory. Finally, find that the communication complexity for single qubits is smaller than 1.28 bits. The previous known upper bound was 1.85 bits. DOI: http://dx.doi.org/10.1103/PhysRevLett.109.110501 **Epistemic View of Quantum States and Communication Complexity of Quantum Channels Phys. Rev. Lett 109, 110501 – Published 12 September 2012 Alberto Montina for models see elsewhere .** Stability analysis of what? Quantum state representing reality or our knowledge of reality? Does the quantum state represent reality or our knowledge of reality? In making this distinction precise, **Nicholas Harrigan, Robert W. Spekkens** are led to a novel classification of hidden variable models of quantum theory. They show that representatives of each class can be found among existing constructions for two-dimensional Hilbert spaces. Approach also provides a fruitful new perspective on arguments for the nonlocality and incompleteness of quantum theory. Specifically, **Nicholas Harrigan, Robert W. Spekkens** show that for models wherein the quantum state has the status of something real, the failure of locality can be established through an argument considerably more straightforward than Bell's theorem. The historical significance of this result becomes evident when one recognizes that the same reasoning is present in Einstein's preferred argument for incompleteness, which dates back to 1935. This fact suggests that Einstein was seeking not just any completion of quantum theory, but one wherein quantum states are solely representative of our knowledge. Hypothesis is supported by an analysis of Einstein's attempts to clarify his views on quantum theory and the circumstance of his otherwise puzzling abandonment of an even simpler argument for incompleteness from 1927. **February 2010, Volume 40, Issue 2, pp 125-157 Date: 09 Jan 2010 Einstein, Incompleteness, and the Epistemic View of Quantum States Nicholas Harrigan, Robert W. Spekkens** statistical model of the probabilistic description of physical reality has been studied by many authors. **Andrei Khrennikov posits** a contextual statistical model of the probabilistic description of physical reality. Here contexts (complexes of physical conditions) are considered as basic elements of reality. There is discussed the relation with QM. He proposes a realistic analogue of Bohr's principle of complementarity. In the opposite of the Bohr's principle, **Andrei Khrennikov** principle has no direct relation with mutual exclusivity for observables. To distinguish his principle from the Bohr's principle and to give better characterization, he changes the terminology and speaks about supplementarity, instead of complementarity. Supplementarity is based on the interference of probabilities. It has quantitative expression trough a coefficient which can be easily calculated from experimental statistical data. There is need not appeal to the Hilbert space formalism and noncommutativity of operators representing observables. Moreover, in our model there exists a pair of supplementary observables which cannot be represented in the complex Hilbert space. There are discussed applications of the principle of supplementarity outside quantum physics. **October 2005, Volume 35, Issue 10, pp 1655-1693 The Principle of Supplementarity: A Contextual Probabilistic Viewpoint to Complementarity, the Interference of Probabilities and Incompatibility of Variables in Quantum Mechanics Andrei Khrennikov Foundations of Physics** Description of the vacuum in Yang-Mills theory and arrive at a physical interpretation of the pseudoparticle solution and the attendant violation of symmetries has been done by **R. Jackiw and C. Rebbi.** It is here vaccuum stability forms the bastion, pillar, post and stylobate of the mechanisms of yang mills Theory and action of a particle. The existence of topologically inequivalent classical gauge fields gives rise to a family of quantum mechanical vacua, parametrized by a CP-nonconserving angle. The requirement of **vacuum stability** against gauge transformations renders the vacua chirally noninvariant. DOI: http://dx.doi.org/10.1103/PhysRevLett.37.172 **Vacuum Periodicity in a Yang-Mills Quantum Theory Phys. Rev. Lett 37, 172 – Published 19 July 1976 R. Jackiw and C. Rebbi.** Three-dimensional Yang-Mills and gravity theories augmented by gauge-invariant mass terms are analyzed. These topologically nontrivial additions profoundly alter the particle content of the models and lead to quantization of a dimensionless mass-coupling-constant ratio. The vector field excitations become massive, with spin 1 (rather than massless with spin 0), and the mass provides an infrared cutoff. The gravitation acquires mass, mediates finite-range interactions, and has spin 2 (rather than being absent altogether); although its mass term is of third derivative order, there are no ghosts or acausalities. DOI: http://dx.doi.org/10.1103/PhysRevLett.48.975 © 1982 The American Physical Society **Three-Dimensional Massive Gauge Theories Phys. Rev. Lett 48, 975 – Published 12 April 1982 S. Deser et al** All scattering amplitudes in the maximally supersymmetric N=4 super-Yang–Mills theory possess a new, dual superconformal symmetry which extends the previously discovered dual conformal symmetry of MHV amplitudes. To reveal this property we formulate the scattering amplitudes as functions on the appropriate dual superspace. Rewritten in this form, all tree-level MHV and next-to-MHV amplitudes exhibit manifest dual superconformal symmetry. We propose a new, compact and Lorentz covariant formula for the tree-level NMHV amplitudes for arbitrary numbers and types of external particles. The dual superconformal symmetry is broken at loop level by infrared divergences. However, we provide evidence that the dual conformal anomaly of the MHV and NMHV superamplitudes is the same and, therefore, their ratio is dual conformally invariant. We show this explicitly for the six-particle amplitudes at one loop. Authors conjecture that these properties hold for all, MHV and non-MHV, superamplitudes in N=4 SYM both at weak and at strong coupling. **Nuclear Physics B Volume 828, Issues 1–2, 21 March 2010, Pages 317–374 Dual superconformal symmetry of scattering amplitudes in N=4 super-Yang–Mills theory J.M. Drummonda DOI: 10.1016/j.nuclphysb.2009.11.022.** By comparison with numerical results in the maximal Abelian projection of lattice Yang–Mills theory, it is argued that the nonperturbative dynamics of Yang Mills theory can be described by a set of fields that take their values in the coset space SU(2)/U(1). The Yang–Mills connection is parameterized in a special way to separate the dependence on the coset field. The coset field is then regarded as a collective variable, and a method to obtain its effective action is developed. It is argued that the physical excitations of the effective action may be knot solitons. A procedure to calculate the mass scale of knot solitons is discussed for lattice gauge theories in the maximal Abelian projection. The approach is extended to the SU (N) Yang–Mills theory. A relation between the large N limit and the monopole dominance is pointed out. **Physics Letters B Volume 458, Issues 2–3, 8 July 1999, Pages 322–330 An effective action for monopoles and knot solitons in Yang–Mills theory Sergei V. Shabanov DOI: 10.1016/S0370-2693(99)00612-7.** It is here the quintessential formulation of consciousness occurs. Like a man standing on the threshold of infinity trying to ponder what lies beyond the veil, which separates the seen from unseen a true seeker tries to lift the individual general ledger to the cosmic general ledger. Like in Darwinian evolution, mind also has to evolve from individual consciousness to cosmic consciousness. In Kaishmiri Shaivism one withdraws from the finite to the infinite, but one also goes on an outward journey from the infinite to the finite, because both the finite and the infinite have an intimate connection. The finite is not seen as unreal, but as a symbol of the infinite. There is no real distinction between them. Those two movements constitute Spanda, a key concept in Kaishmiri Shaivism. Spanda is the pulsation of the Absolute in different phases of being. There are no opposites like subject and object, unity or duality, absolute or relative. They are just different phases of the universal vibration of the Absolute. The goal is to realize or be at once infinite and finite. One does not turn away from appearances (like in Advaita Vedanta), but one realizes that the Absolute manifests all things. Spanda, the eternal pulsation of the Absolute, oscillates between a passion to create and dispassion from the created. Through it the Absolute transform itself into all things and then returns back into the emptiness of its undifferentiated nature. In Kaishmiri Shaivism the Absolute is seen as pure consciousness (=being). The Absolute is an eternal all-pervasive principle, the highest reality, the nature of all entities eternally and blissfully at rest within its own nature. The Absolute is the nature of the Self (and thus of us all). The Absolute is divine, it is Shiva, the Lord of the Universe. It is full of conscious activity through which it generates the universe, and reabsorbs it into itself at the end of each cycle of creation. Thus we speak of monism, as everything resides within this one absolute consciousness. It sustains all things, it embraces all things, and it pervades all things. All things are appearances within the absolute consciousness, but nevertheless real (in contrast to Advaita Vedanta where appearances are seen as unreal or illusionary). All things appear external (out there, outside ourselves), but they do not have a being on their own.

They do not exist as separate entities on their own. Everything is contained within consciousness. What we see as objects are manifestations of consciousness. The event which constitutes the universe is always internal events happening within consciousness because their essential nature is consciousness itself. If a physical object were totally material, and independent or external to consciousness, it could never be experienced. The universe and consciousness are two aspects of a whole. The universe is an attribute of consciousness which bears consciousness as its substance. Doctrine of Vibration: S.G.Dyczkowski What you "see" is not always what you "get." Many people mistakenly take their own visions literally without "seeing through" the various possibilities that are outside their belief system, knowledge or skill base. Deeper reality is not remote in the physical sense but in a psychological sense. The archetypes of the collective unconscious are arrayed behind the scenes of current worldwide conditions, of crisis and confusion. They mirror our own states back at us, whether we perceive them as such or interpret them plausibly or not. The noise of ordinary consciousness and beliefs drowns out the signal. Unconsciousness is the background of our ordinary awareness. Our organism is very much at the center of such effects. The organismic source is our human bodies and the focus of human consciousness. The fantasy principle dethrones reality, but can be dissociative or compensatory. The human mind is a meme-Scape. Pre-conceived concepts vie with structures, concepts with images. Like scientists who ignore assumed truths, we leapfrog over our beliefs and personality deficits, claiming idiosyncratic imagination is literal reality. It couldn't be further from the truth and symbolism is utterly lost. The metaphor that might heal us enslaves us. Perhaps images like the holographic universe have an implicate order. Can we have a sense of the cosmos in the world without projecting myriad fantasies on it that we embrace literally? Has the world become so horrible it is unreasonable to be realistic? We may need to look at our drives and wishes, rather than the fantasy content. Psyche constructs reality. Our experience of so-called reality is always mediated by our image of it. Even if all the contents of the psyche are real, that doesn't mean they are realistic. That psyche is real is still a radical proposition, but psychic politics certainly color the self-image and ideas of everyone. We observe and participate with images It is not a question of nature or nurture (genes alone or experience alone). Rather, everything is both. We inherit the structures that make our experience what it is. But the structure itself is “empty,” and each human culture “fills” it with its own specific adaptations. It is difficult to define an archetype and set boundaries that distinguish it from others. In a hologram each part contains all the information but in lower resolution. Archetypes have this holographic quality. There are patterns within patterns within patterns. Some overlap with others, and some are nested inside others. Archetypal realities, passed on through DNA, are expressed in distinctive neuronal tracts in the brain. They include customs and laws regarding property, incest, marriage, kinship, and social status or roles; myths and legends; beliefs about the supernatural; gambling, adultery, homicide, schizophrenia, and the therapies to deal with them. A mythic and visionary language of immediate experience encompasses themes of deepest, highest, and ultimate concern. Most fantasy-based individuals are at a complete loss to coherently explain their own conventional behavior much less anomalous events and their deep meaning, much less the cultural unconscious or mythological unconscious matrix. But they try, and become utterly entrenched in their belief that they are right about the nature of the world and reality. We have pseudo-memories about our personal lives. Why not more so for our collective life? The subject matter often revolves around catastrophe, creation and the mythopoeic forces of mankind. Ignorant of such dynamics, interpretive mistakes and displaced psychic contents proliferate into errors of fact. Propaganda, media distortions, memes, and disinformation compound the social problem of misapprehension further. Shameless self-promotion by personalities of such ideas leads to cults. They make up myths about the myths of by-gone eras. Roiling unconscious images can be fatally confusing. Thought illusions culminate in projections and projections of mythology. Jung suggested symbols live only as long as they are pregnant with meaning. Philosophy arose from criticism of myth, from discussing and challenging it. In science, we criticize, reject and eliminate theories. At the edge of the abyss of the unknown, new signs and symbols emerge. Credible theories and paradigms must include biology, physics, and neurophysiology. One of the reasons people "see God", or a guru, or anomalies may be because our brains are constructed to see reality through the eyes of others. There are heaps of mirror neurons which are there to make us feel the 'other'. Mirror neurons do for psychology what DNA did for biology. They provide a unifying framework and help explain a host of mental abilities. As in the psychochemical processes of empathy or falling in love, a complex feedback loop sustains a state of mind. But when we empathically transpose ourselves into someone else's position, we expose ourselves to that reality -- cognitively and emotionally. The unconscious complicates empathy, both ways. Mirror neurons might well play a role in bonding, language and self-awareness. Naively, we take too much as self-evident. But 'seeing' does not always 'believe', though many make this error or leap in logic and formulate their choices and future accordingly. Yet, there is only one way to learn what consciousness is. Experience. But we have no satisfactory explanatory edifice for consciousness. Would such a theory release in each of us our own inner knowledge of the creativity of our own consciousness, and its infinite possibilities? The problem is trying to define a verb, a dynamic, as if it were a noun. But we do recognize the effect of consciousness. It functions to mediate states of consciousness, high and low psychobiological arousal. Consciousness is the subconscious lifted up by the physical body. When the body fails, the consciousness collapses back into the subconscious. All our thoughts come from the subconscious which can see our intentions but not our world. This relates somehow to intention being imaginary and not of the physical frictionized world (King). Gerald Edelman postulates that the flows of information in the brain are mediated through 're-entrant' feedback loops. As evolution provides new cognitive functions, new re-entrant loops are established. Even language itself is an archetype -- a chaotic field of dynamic associations. A subtle net of tropes, grammar, symbols, and meaning, the program language begins in limbic resonance. Some phenomena generate their own language patterns, nomenclature, and internal coherence of meaning and representation. In a holographic universe, even time and space could no longer be viewed as fundamentals. Because concepts such as location break down in a universe in which nothing is truly separate from anything else, time and three-dimensional space would also have to be viewed as projections of this deeper order. At its deeper level reality is a sort of super hologram in which the past, present, and future all exist simultaneously. This suggests that given the proper tools it might even be possible to someday reach into the super holographic level of reality and pluck out scenes from the long-forgotten past. Or not. A fantasy of such penetration or phenomenon inside the head is not the same as that penetration. **Jung in the 21st Century: Synchronicity and science By John Ryan Haule Mind Control Countermeasures.** The lower domain of experience is what we do not directly observe, the quantum realm, while the higher level is what we ordinarily observe, the classical realm. Based purely on experiment, the formulation of quantum theory initially placed the great divide between the quantum and classical domains between the measuring apparatus and the particle (Herbert, 1985). However, in the early 1930s, John von Neumann, in his rigorous mathematical treatise on quantum mechanics, found no support for such a division, compelling him to conclude that the wave for was collapsed by consciousness. Von Neumann's treatise has been called the "quantum bible" and "the most influential book on quantum theory ever written" (Herbert, 1985). The von Neumann formulation leads us to conclude that the lower realms of quantum reality form a virtually limitless array of potentials that are inherently incapable of realization without the observation of a knowing entity, which we identify with consciousness (Kafatos and Nadeau, 1990). We thus have a correspondence between quantum theory, the hierarchical structure implied by the Holographic Principle, and the higher orders of experience, leading to the full expression of the Conscious Universe. David Bohm's theory of the implicate and explicate orders involves a holographic Principle that is fully consistent with the Holographic Principle discussed here (Bohm 1980; 1986; Bohm and Hiley, 1993). According to Bohm, there is an implicate order that represents the universal, holographic subtext of reality, and which unfolds in every moment to produce the explicate order that we all observe. Thomas Germinario (2004) has equated the implicate order with (eb) the unconscious process, and the explicate order with (eb) conscious process. He emphasizes the nature of dreams within (eb) the implicate order, and the importance of the dream work for maintaining a healthy mind through (e&eb) integration of the implicate order and our daily lives. Allan Combs and Mark Holland (1990) connected the implicate order or holomovement (Bohm, 1980) with (e&eb) Carl Jung is theory of synchronicity (Jung and Pauli, 1955), with (e&eb) the implicate order providing (eb) a holographic medium through which apparently disconnected individuals become connected. The principle of synchronicity, the instantaneous connection of people and events beyond (e) the senses, has been equated with the quantum-physical principle of non-locality (Combs and Holland, 1990; Germine, 1991), and has been proposed to be the fundamental mechanism of conscious process (Germine, 1991).Applying the Holographic Principle theory of mind, subjects may be connected synchronously in the manner of two individuals conversing through cellular phones, where the radio signals are transmitted through (e&eb) a distant satellite. The difference here is that the radio signals travel at the speed of light, and thus the there is some miniscule time lapse between the sending and receiving ends. The Holographic Principle implies (eb) a much more distant and instantaneous communication pathway, with (e&eb) the analogue of the satellite being the holographic boundary of the Universe, as well as a much richer communication, potentially involving a transmission of thoughts and feelings. Our ego-consciousness seems to mask the universal relatedness implied by (e) the Holographic Principle, and it is perhaps only through transcendence of (e) the ego-consciousness that the higher orders of experience can become conscious. In the phenomenon of synchronicity, there seems to be a meaningful connection between (e&eb) individuals that breaks through the barrier of ego-consciousness. Such a connection is reported by many individuals in the course of dreams, when (e) the ego-consciousness has been suspended, at times informing (e&eb) the dreamer of something that has happened in the life of a meaningfully-connected individual. **The Holographic Principle Theory of Mind MARK GERMINE Institute for Psycho science** Impassioned-intense Connectionist neuroscience, in an effort to attain relevance to clinical practice, has recently given us a theory of the relationship of the unconscious to (e&eb) consciousness which is (=) dualistic (Viamontes and Beitman, 2007), an ad hoc theory of conclusions based on (e) assumptions, the most erroneous of which are that representations of (e) information are information, and that such representations elaborate themselves through (e&eb) a process of representations of representations in neuronal circuits (Bechtel and Abrahamsen,1991). As theory, the connectionist models are lacking (e) heuristic value and **are (=) inimical to the progress** of (e) basic and clinical neuroscience. This is not to denigrate or minimize the importance of neuronal connections, but these connections are rather like the wires in (eb) a radio that plays a symphony. The radio, in and of itself, is (=) incapable of playing (e&eb) the symphony. The radio doesn't do not write the symphony, nor does it broadcast the Passionate-raging symphony over the airways. Yet, if we loosen one wire, the symphony is (=) not manifested through the radio. The brain is (=) not subject to (e) the same vulnerability, in that it has (e) parallel and redundant networks of processing, and, it is in this sense that the connectivity of the brain becomes (eb) important. Connectionism, to the extent that it accepts (e) consciousness and the (e&eb) unconscious at all, attributes them to (e) separate groups of "circuits" in the brain, with (e&eb) consciousness-processing circuits having (e) a limited but detailed ability to analyze (e&eb) information, and unconscious-processing processing more information in less detail (Viamontes and Beitman, 2007). There is an element of truth in this view in that information that has importance and meaning resonates within the brain at higher levels of experience and at higher levels of holographic recursion. This resonance involves what we know, what we feel, and what we are capable and willing to consciously realize. The Universe, as William Blake noted, can be seen in a grain of sand. Indeed, the grain of sand requires (e) the Universe to exist. The human organism requires (e) the Self to exist. The Self is not a simple amalgam of (e) sensory experiences, as suggested in the connectionist model (Blinder, 2007). This amalgam view of the Self can be damaging when applied to (e&eb) psychotherapy, as the connectionists suggest (Blinder, 2007). The Self is ours forever and ever, from eternity to eternity. As Milton suggested, the mind is (=) its own place. Our deepest purpose is for our minds to resonate with (e&eb) the supra-conscious levels of experience, much as it is (=) purpose of the radio to play the symphony. If the symphony is not to our liking, (eb) we can turn the radio off. So, perhaps, the transpersonal consciousness can turn (e&eb) our own individual and collective radios off, or perhaps turn the volume down, if (e) we are not in harmony with the **Universal Mind**. Physics has given us many enigmas. Quantum theory itself is an enigma. But some of the enigmas seem to involve (e&eb) the limitation of (e) our own abilities of discernment. The thought experiment of (e) "Schrödinger's Cat," as it is often interpreted (e.g. Gribbin, 1984), assumes (eb) that the **cat is not conscious, and is (=) incapable of observation in the context of (e) collapse of (e) the wave function.** This is due, in large part, to the false dichotomy of (e) information and (e&eb) experience. Our observation of other animals indicates, to those that are attuned to (e) the animal mind, who can "feel" the animal mind, that, at (eb) the very least, all mammals are (=) conscious. It would seem that the great neuropsychiatrist, Stanley Cobb (1948), may have been correct in his attribution of (e) levels of consciousness to a wide variety of organisms: "...lower animals with (e&eb) no cerebrum appear to be conscious...even plants such as the sunflower that turns towards strong light may have (e) a vague awareness or warmth and comfort. There are many degrees of consciousness and it is my contention that it is integrated at (e&eb) many levels like other important functions of (e) the central nervous system."With respect to the theory of mind, recent mainstream thinking remains (eb) classical and mechanistic. Such views of mind are advocated by our most in prominent neuroscientists (e.g. Changeux, 1985; Gazzaniga, 1985) as neuroscience research attempts to explain all mental function on the basis of (e) **pure mechanism and the localized function of specific areas of the brain.** Francis Crick, the distinguished Nobel Laureate, had a very influential second career as a neuroscientist. He concluded that we are basically soulless creatures, that all mental processes could be reduced to (e&eb) identifiable, neural correlates in (eb) the brain, and that, in fact, we are (=) nothing but a collection of neurons (Crick, 1995). Crick even went so far as to say that what we call the soul is (=) a group of neurons located in the prefrontal lobes of the brain. Another Nobel Laureate, Gerald Edelman (1987), has written a critically acclaimed book on "neural Darwinism," which purports that the brain is "circuitry" is constructed through a developmental process of "survival of the fittest" neurons and neuronal connections. At the same time the total purposelessness and lack of direction in evolution is expounded, again to critical acclaim, by Richard Dawkins (1986). The idea that there essentially no self or soul imbued with agency and self determination was expounded by Gilbert Ryle (1949/2002) with his parody of the "ghost in the machine," and this work continues to be influential among many scholars of the mind. Philosophers such as Patricia Churchland (1986), who coined the term "neurophilosophy," take an "eliminative materialist" view of (e) belief, free will, and consciousness. Other philosophers, such as Daniel Dennett (1991) would make (eb) experience "epiphenomenal," a by-product of (e) brain processes with (e&eb) no effect whatsoever on (eb) the function of mind. However, unlike neuroscience, which is still in its infancy, the philosophy of mind has had a long history, including such notable figures as Plato, Aristotle, Descartes, Kant, Locke, Hume, Kierkegaard, and James, to name just a few. Perhaps, as noted by Ervin Laszlo (1974): "in today's world, most of the traditional functions of (e) cognitive synthesis have atrophied (e) and are ignored and neglected." Hopefully, what we have presented here will be a step in the right direction for what Laszlo calls a "conceptual synthesis" to help fill the need for (e) meaningful engagement is such a world. The fundamental elements of such a synthesis have been described by (e) Laszlo as follows: Conceptual synthesis performs (e&eb) at least five basic functions in the guidance of affairs. They are the mystical, the cosmological, the sociological, the pedagogical or psychological, and the editorial functions. The mystical function inspires (eb) in man a sense of mystery and profound meaning related to (e&eb) the universe and of himself in it. The cosmological function forms (eb) images of the universe in accord with (e&eb) local knowledge and experience, enabling (eb) men to describe and identify (e&eb) the structure of (e) the universe and the forces of nature. The sociological function validates supports and enforces (eb) social order, representing (eb) it in accord with (e&eb) the nature of the universe, or as the natural or right form of (e) social organization. The pedagogical or psychological function guides (eb) individuals through stages of life, teaching ways of understanding themselves and others and presenting (eb) desirable responses to life is challenges and trials. Finally, the editorial function of (e) conceptual is to define (eb)some aspects of reality as important and credible and hence to be attended to, and other aspects unworthy of serious attention. **The Holographic Principle Theory of Mind MARK GERMINE Institute for Psycho science** Kant sums up this inversion and its spirit early in the Critique of Pure Reason: Up to now it has been assumed that all our cognition must conform to the objects; but all attempts to find something about them a priori through concepts that would extend our cognition have, on this presupposition, come to nothing. Hence let us once try whether we do not get farther with the problems of metaphysics by assuming that the objects must conform to our cognition, which would agree better with the requested possibility of an a priori cognition of them, which is to establish something about objects before they are given to us. This would be just like the first thoughts of Copernicus, who, when he did not make good progress in the explanation of the celestial motions if he assumed that the entire celestial host revolves around the observer, tried to see if he might not have greater success if he made the observer revolve and left the stars at rest. (B xvi) Onticology, like all variations of object-oriented ontology, is realist in its orientation. In defending a realist ontology onticology holds that the vast majorities of objects, actants, beings, or entities are independent of humans and are what they are regardless of whether any humans regard them or register them. In short, onticology rejects any anthropomorphic, idealist, or anti-realist thesis to the effect that to be is to be the correlate of mind, spirit, the body, the human, and language or otherwise. While it is certainly the case that knowledge is necessarily dependent on the object to which it relates, the converse does not hold true. Objects are not dependent on being known, regarded, perceived, or spoken about. As such, and to put it in Aristotlean terms, knowledge is an accident of objects, not objects an accident of knowledge. As Althusser so nicely puts it, "[n]o doubt there is a relation between thought-about-the-real and thisreal, but it is a relation of knowledge, a relation of adequacy or inadequacy of knowledge, not a real relation, meaning by this a relation inscribed in that real of which the thought is the (adequate or inadequate) knowledge" (Reading Capital, 96). Althusser goes on to remark that "[t]he distinction between a relation of knowledge and a relation of the real is a fundamental one: if we did not respect it we should fall irreversibly into either speculative or empiricist idealism" (ibid.). Onticology categorically endorses Althusser's verdict. It is a fundamental necessity to distinguish between those relations that belong to the object and those that belong to knowledge. Contemporary philosophy continuously confuses these two very different sorts of relations. Naturally the question arises of how it is possible to surmount our relation to the object so as to determine whether objects themselves possess the properties we encounter in relating to objects. In other words, given that we can only ever relate to the object in relating to the object how is it possible to surmount this relation to get at the being of the object itself? Much more will have to be said about this later– and the answers will be surprising with respect to standard prejudices about realism –however, for the moment it can be said that onticology takes its epistemological inspiration from the transcendental realism of Roy Bhaskar. Among other things, Bhaskar sought to provide a transcendental grounding for the sciences. Insofar as onticology defends the thesis that the field of being is much more vast than the field of objects investigated by the natural sciences, it parts way with the thesis that the domain of being is exhausted by the domain of natural objects. However, the general form of Bhaskar's argument holds for our realist purposes. A transcendental argument seeks to elucidate the conditions under which certain acknowledged practices and forms of cognition are possible. Kant, for example, asked what must be the case for mathematical judgments to be possible. How is it both that we are able to extend our knowledge, as if by magic, through mathematical judgments and, more significantly, that these judgments are able to provide genuine knowledge of the world despite the fact that these forms of reasoning are not based on experience? Part of Kant's argument consisted in claiming that mind imposes the forms of space and time on the data of experience. In other words, space and time are not attributes of being itself but rather of the mind that regards being. Insofar, Kant argues, as mathematics is ultimately a rumination on the nature of space and time taken in their most abstract form and insofar as the mind imposes space and time on the manifold of sensation, it thus follows that a priori judgments about the nature of spatio-temporal relations are possible that anticipate the structure of actual-space times without directly experiencing these space-times. Why? Because any manifold of sensation must necessarily be structured by these forms imposed by intuition. **Onticology– A Manifesto for Object-Oriented Ontology Part I Posted by larval subjects under Object-Oriented Philosophy My Question Is This: You Say, "Granted There Are Deeper And Deeper And More Primitive Forms Of "Knowledge" Or Abstraction Into Mechanism, But I Wouldn't Say That The Atomic Level Brings A New Epistemic World Into View." But Doesn't Any Kind Of Knowledge, However Primitive, Imply Bringing Some Kind Of Epistemic World Into View Or Proto-View?** Joel: David, Yes Exactly. My Question Is, Just How Far Down The Complexity Gradient Can The Meaning Of 'Knowledge,' Or 'Semiotics, Or Specifically Representation (Maya) Be Stretched Without Breaking? I Can Comfortably Stretch It To The Genetic Level, As The Proto-Epistemic, Where Genetic Codes 'Represent' Phenotypic Structures Or Modes, And The Whole Of Evolution Learns From Its Mistakes And Successes As That Knowledge And History Is Encoded Into And As The Recapitulation Of The Embryogenesis Of The Organism. But An Atom, In My Model, While Certainly Reacting To Its Environment From Its Own Attractor, Essence, And 'Interiority' (Prehension) Isn't Making Representations Of It To Do So. But The Key To The Power And 'Essence' Of Representation (And Simultaneously Its Limitation) Is The Capacity Of Abstraction And Choice. Evolution Does This At A Rudimentary Level (And Anthropomorphizing A Bit) With Its Sending Into The World Its 'Random' Variations, Organismic Ideas, In A Sense. Its 'Mind' Is Literally On The Outside As Our Living World And Biosphere. A 'Choice' Is Made In The Biospheric Interiority, And Knowledge For The Evolutionary/Embryogenetic Trajectory Is Gained By The "Differential Reproductive Success" Of These Individuals Lives Through Time, As The Increasing Intelligence, Representation, And Capacity For Choice Is Directly Injected Into The Flow Through Sexual Selection. But Where Is The Encoded/Abstracted (Enfolded) Representation Of Options And A Choice Among Them Made At The Atomic Level? I Am Working

With The Most Cutting-Edge And Coherent Models For The Atom (Including My Own) That I Can Find Among The Heterodoxy, And I See No Evidence Of Representation And Choice At This Level, Or Rather No Real Way To Further Stretch The Meaning Of The Terms To This Level. Sure There Is Uncertainty From Infinite Difference And Immanent Causation (See Bohm On Infinite Causation), But Without Representation There Really Is No Choice (Although Crudely We Could Call A 'Bifurcation' A 'Choice' By The System As A Whole). So I Am Simply Saying That Representation At The Atomic Level Is Entirely Enfolded And These Are Really Just Ontic Level Phenomena. The Atomic Level, In My View, Is Pre- Not Yet Proto-Epistemic, Which I Place At The Genetic Level Where We Find The First Codes And Primitive Representation. This Just Means That There Is A Real Distinction Between Ontic And Epistemic (And A Gradient Between Them) And We Can't Collapse The Two Into Just The Ontic-Epistemic. And Yet, With The Distinction Intact, And The Gradient To Explore, They Remain Nondual, Univocal, ONE Or Ontic.What I Would Say Exists At All Levels (My Own Self-Aware Myth About The Given) Is What I Call The "Symbiogenesis Of Subject And Object". This Is The Spinozan Essence Of Dynamic Stability And Growth, And Leibnizian Prehension. Also Called The "Nucleation Of Observability" In Spinbitz. It Is From This Nucleus Of The Observer (Fuller) In A "Point-Free Geometry" (Whitehead) Of Pointless "Points Of View" As Conditions Of Boundary That Wilber's "All Is Perspective" Finds Its Ontic Grounding. And This Symbiogenesis Is Also A Rudimentary Or Deep-Level Native Or Primitive Intelligence, Evolution At The Involution Of The Subject-Object Interface. It Is An Exploration Of Creative Learning And Direct Immanent Awareness, Unmediated (Enfolded) By Representational Forms (Unfolded). It Just Is, In Waves (Cosmic Vertebrae) Before It Abstracts, Represents And Incarnates The Flesh Of What Could Be. Matter Is Enfolded Seed Of The Flower Of Its Abstraction. Maya Is This Depth And Recursion Of Brahma Into And Through The Boundary Conditions Of Abstract Relation. And Brahma Is The Span Of The Emergent Rigor Of The Cosmic Ergodic Spine That Opens The Recursions Into The Field Of Infinite Difference. In Immanent-Transcendent Waves, Literally And Empirically A Limit-Cycle In Ergodicity, It Enfolds And Unfolds From Anatom To Anatomy, From Infinite Intelligence Or Omnirelational Awareness Of Self, Through The Representational Depths Of Self As Self-Consciousness. Omni-Evolution, Trans-Dynamics, And The Anatom Posted On February 21, 2013A Discussion With Tom Huston, Part II The Following Is Part 2 Of An Excerpt From A Discussion Initiated By Tom Huston On His Facebook Page, Edited And Embellished For Clarity. Find Part One, Here. In This Part We Dig Into The Nature Of The "Anatom" And The "Ergodic Spine" Of An Electro-Fractal Cosmos, And Into The Trans-Dynamic Integration Between Being And Becoming, And The X-Interface–The Crossroads Of The Ontic-Epistemic (Brahma And Maya) And The Subject-Object Polarities. Univocal_Dynamics_V1 Tom Huston Is A Founding Member Of Integral Institute And A Former Editor Of Enlighten Next Magazine. His Webpage Is Tomhuston.Com. David Marshall Is A Writer And Editor Living In Chicago. No meaning, value, or normativity to be found in nature, that there is nothing **natural beings ought to be,** but that, rather, these judgments arise from us (See last post of larval subjects) which has led some to raise valuable questions about the coherence of these claims. The problem arises when the following three propositions are taken together: 1. there is nothing outside of nature.2. Beings have no intrinsic meaning, purpose, or value (in and of themselves, there's nothing they ought to be). 3. Value judgments about what beings and being ought to be arise from us and beings like us (bonobo apes, dolphins, institutions, birds of paradise, etc). The problem arises between proposition 1 and 3. How can it both be true that there is nothing outside of being and those normative judgments belong to us and other beings capable of making normative judgments, not nature? The problem arises from restricting these judgments to humans and beings capable of making these judgments. In making such a claim it seems as if we're saying that there's something outside of nature, something that is beyond nature, thereby violating the first thesis and potentially reintroducing the nature/culture distinction. By contrast, if we say that normative judgments are the special domain of those living beings with the proper degree of sentience to make such judgments, then we seem to reintroduce the nature/culture distinction and fall back into the sorts of problems that I outlined in my last post (and that are so nicely critiqued by thinkers such as Latour). Is there a way out of this? I don't know. Great_Chain_of_Being_2_ (lighter) ASIDE: It seems to me that this is really what the debate between realism and anti-realism, realism and socio-linguistic constructivism surrounding the new materialisms and speculative realists has really been all about. It's very easy to treat this as an abstract, academic debate: "Are you a realist or are you an anti-realist?", as if it were just a matter of what happens to be true. But it seems to me that this debate has, in reality, always been about politics. As I outlined in my last post, we have perpetually seen how appeals to the real and natural have been used in the name of oppressive power, inscribing both the exploitation of nature and the oppression of various people in the very fabric of being itself. Theistic theology and realist ontology have perpetually been used in the name of what Deleuze called "State Philosophies" or philosophies that ontologize contingent orders of power and privilege (e.g., "the great chain of being" used to justify patriarchy, monarchy, serfdom, poverty, etc, and appeals to nature used to justify poverty and racial inequality (The Bell Curve), patriarchy (evolutionary psychology), heteronormativity, capitalism, etc). Because arrangements of power and inequality are always contingent in the sense that there's no marked difference in the capacities of peoples, power always looks for a transcendent supplement that would provide justification through ontological necessity. Antirealism– from the Greek atomists to present –became the radical and emancipatory gesture because it revealed the lie behind all of these forms of social organization or their inherit contingency or arbitrariness. Realism, by contrast, has all too often functioned as an apologetics for arbitrary power and social organizations. Here it's worth recalling what Foucault said about science: "…Even before we know to what extent something like Marxism or psychoanalysis is analogous to a scientific practice in its day-to-day operations, in its rules of construction, in the concepts it uses, we should be asking the question, asking ourselves about the aspiration to power that is inherent in the claim to being a science. The question or questions that have to be asked are: "What types of knowledge are you trying to disqualify when you say that you are a science? What speaking subject, what discursive subject, what subject of experience and knowledge are you trying to minorize when you say 'I speak this discourse, I am speaking a scientific discourse, and I am a scientist.' What theoretico-political vanguard are you trying to put on the throne in order to detach it from the massive, circulating, and discontinuous forms that knowledge can take?" (Society Must Be Defended, 10). All of these questions hold equally for claims to something being real. What is one trying to minorize when claiming something is real? What becomes privileged? What is excluded? It is these questions that have been at the heart of the realism debates, for as Spencer-Brown taught us, every distinction has a marked and unmarked space, draws attention to something to be included and pushes something into the unconscious or the domain of the invisible, hidden, or veiled. This is above all the case with evocations of the real. However, as I've tried to show antirealism leads to its own problems. First, so long as we exclude real beings from our ontological inventory, we are unable to fully understand how power functions ("such and such a set of cultural formations have been thoroughly debunked, yet people still live as if they believed them"). Not only do we not fully understand the sources of the problems due to too much focus on the discursive and semiotic, but we deny ourselves valuable sites of political intervention at the level of infrastructure. Second, we are prevented from addressing things such as cultural racism, such as that found in Heidegger's privileging of the West and the Greeks and Germans in particular. We do a good job addressing biological and theological racism, heteronormativity, and sexism by showing how it is a cultural construction, but when faced with racism such as Heidegger's where he argues that there's something "unique" about the Greek event, it's language, and about the German language, or Badiou/Zizek's racism with respect to the "Pauline Event", we really have no response. Here someone like Jared Diamond or Fernand Braud el is needed to explain global-geographical inequalities. Third, the tools of the cultural turn really do not provide us with the means of thinking the ecological as a site of the political. For this reason, I've tried to formulate a third way– which might be called "constructivist realism" or "constructivist naturalism" –that retains the insights of the cultural turn, while also allowing a robust place for the material. I don't claim to be original in this. I think that many such as Manuel DeLanda, Deleuze and Guattari, Stacy Alaimo, Karen Barad, Jane Bennett, etc., are up to something similar. It's a vast project that requires the work of a multitude of voices, especially given the way in which the culturalism pervades humanities. **The Relational and the Non-Relational: Notes towards an Immanent and Pluralist Theory of Meaning Posted by larval subjects under uncategorized k-bigpic I have deleted or reformulated some sentences for which I beg pardon attributable to spatial constraints** What is correlation, what is causation? What is coordination? What is coincidence? These thoughts have bothered humans since long. I have been able to excavate some reliable material from Wikipedia which I would like to share. "All views are partial and contingent – that's the lesson of pluralism, and you say as much yourself when you say that we must be attentive to ways our own knowledge might contain superstitions. But it's not discourse that determines whether one view works and another doesn't – it's a confrontation with **non-discursive (non-human)** agencies." I wonder if part of the issue here is that we understand pluralism differently. For me this doesn't sound like pluralism at all. Rather, it just sounds like our **epistemological condition**. We [hopefully] come to understand those portions of existence we question or investigate. The reason we come to investigate them is largely contingent. Finally, the accounts of these features of existence we give can be mistaken. All of this is perfectly consistent with a monism. I'm not sure why what he outlines above is the lesson of pluralism. It seems to me that every realist knows this. It seems to me that ontological pluralism is something quite different. Ontological pluralism is the thesis that there are many different worlds inhabited by many different entities. Thus, for example, you would have one world; say that of Lucretius, that's only inhabited by atoms and their combinations. You would have another world; say the world of the Mongolian shaman, that's inhabited by spirits that do all sorts of things. The ontological pluralist is saying that these spirits are, that they exist, that they're real. This is something quite different than merely saying that there are partial and contingent points of view on the world. It's this saying that these entities are rather than that some person or groups of people believe that they are that is the nub of the issue. Now, I think part of the issue here is that there's an ambiguity in the term ontology. Ontology can be one of two things. On the one hand, ontology is a group or persons set of beliefs as to what is. Here it's trivially true that there are pluralities of ontologies and the realist readily recognizes this. This is the whole reason there are debates over ontology. Mongolian shamans have their ontology, Europeans theirs, Christian fundamentalists theirs, materialists theirs, etc. When striving to understand and communicate with others it's vital to understand these ontologies because, as rhetoricians like Burke point out, our **beliefs about what is** are among the things that motivate our action. Despite having never seen bacteria I was my hands because I believe there are bacteria and viruses on door handles and whatnot and don't want to get sick. My belief about a particular thing existing is what motivates my action. And who knows, perhaps this belief is as superstitious as the belief that the crops failed because God was displeased with my community. On the other hand, ontology is a theory **about what is.** It is making a claim that something exists. This is where the rubber hits the road. The ontological pluralist seems committed to the thesis that every group set of beliefs about what exists is sufficient for granting the existence of those entities. This is what I find objectionable in Latour. Obviously I'm not bothered by Latour's suggestion that we should take into account the role that nonhumans like speed bumps, rivers, microbes, etc., play in the form that social assemblages take. But this is not all that Latour claims. This is precisely where the philosopher might balk. Unlike the ethnographer, the philosopher is not interested in what people believe exists, but rather philosophers– at least of the realist variant –are trying to figure out what is. In other words, the realist philosopher begins with the premise that not all of these beliefs about what is are true. So for the philosopher, recognizing that Mongolian shaman's believe in the existence of shamans would only be the first step. The next step would consist in determining whether there's good reason for thinking such entities really do exist, i.e., whether there's good reason for believing these entities have mind and culture independent reality. Lest readers think that I'm just picking on the supernatural here, we can ask similar questions about strings, subatomic particles, galaxies, etc., etc., etc. I guess the question really comes down to what exactly we mean by ontological pluralism. When we talk about ontological pluralism are we defending the thesis that people have different theories of being? If so, then ontological pluralism is trivially true. If this is what is meant, then I certainly share Jeremy's view that it's valuable to understand the different world's people believe in. Certainly when I was practicing as an analyst I didn't get in ontological debates with my patients and it was necessary to understand their theory of being or their ontology to properly attend to them. Or, when we talk about ontological pluralism are we defending the thesis that all these ontological theories are true and refer to really existing entities? That's quite a different claim and is not one I would defend or endorse. Now someone might object that "in both The Democracy of Objects and Onto-Cartography you defend the thesis that there are multiple worlds." This is true. Because I hold that not everything is related I'm led to the conclusion that there are diverse worlds. However, I also hold that however many worlds there might be, these worlds are nonetheless composed solely of material entities. Within the framework I propose I wouldn't suggest that there's one world where there are spirits and another world where there are souls and yet another where there are only material entities. My view is that there aren't spirits or souls in any of these worlds. One of the things I keep hearing in these discussions is that somehow the realist adopts a view from nowhere. I honestly don't understand this criticism. Investigation always occurs somewhere and requires all sorts of mediations involving technologies, experiments, etc. It's that labor of gathering evidence, conducting experiments, using technologies to observe the world, etc., that gradually gives us a body of data that allows us to say there's good reason to believe that such and such a thing exists and has these powers. Another charge seems to be that the realist refuses to recognize that their claims about the world are fallible. I find this charge particularly strange because it's precisely because the realist recognizes the difference between our theories of the world or what we say about the world and the world itself that fallibility is built into the core of his position. Realism doesn't mean one holds they have special access to the world, that they know all truths, or that they have the truth in hand, only that there are truths to be known and that we can be mistaken about things. Circling **Squares Philip** has a post responding to my quandaries about how to mesh realism and pluralism. He writes: Ontologically and metaphysically the idea of realist pluralism is no longer an issue. There are (appropriately) numerous variants but the basic idea that reality is itself pluralistic is well established. The question is political-discursive. It's what Stengers and Latour are getting at with their concepts of diplomacy and cosmopolitics. They grant, first, that all entities exist and, second, that to say that someone's cherished idol (or whatever disputed entity they hold dear) is non-existent is a **'declaration of war'** – 'this means war,' as Stengers often says. They thus shunt onto-political discourse off of the terrain of knowledge/belief in the sense of existence/non-existence. Their basic claim seems to be that 'respect for otherness,' i.e. political pluralism, can only come from granting the entities that others hold dear an ontology, even if you don't 'believe' in them. You are thus permitted to say 'I do not follow that god, he has no hold over me' but you are not permitted to say 'your god is an inane, infantile, non-existent fantasy, grow up.' And it's not just a question of politeness (although there's that too). The point is to grant others' idols and deities an existence – one needn't agree over what that existence entails, over what capacities that entity has or what obligations it impresses upon you as someone in its partial presence but to deny it existence entirely is to 'declare war' – to deny the possibility of civil discourse, of pluralistic co-existence. I believe that it was Richard Rorty who once quipped something like claims to reconcile realism and idealism always seem to end with a triumph of idealism. We don't, in fact, get realism through such approaches, but rather just get a pervasive anti-realism. I think this is also the problem with the "non-controversial pluralism" advocated by Stengers and Latour that Phillip defends here. Such pluralism is not realism but is, in fact, a thoroughgoing social constructivism. I think this is the central problem with Latour's argument in Irreductions (these days I regret having ever defended it). In rejecting both Enlightenment critique and what he calls "reduction" he wants to say something like "The Pentacostal really is filled with the Holy Spirit", that for the 19th working scientist heat really is a fluid and phlogiston really is what allows things to burn, and that for the Greek lightning really is an expression of Zeus's anger. Latour tells us that we aren't to reduce or explain away the entities posited by another group's "ontology" but are to develop explanations from within that ontology. It might not sound particularly sexy– and it certainly doesn't tell us what is worth thinking –but I can't help but believe that philosophy is the critical and reflective investigation of basic concepts that guide our investigation of the world about us, how we ought to live our lives, and what form of governance might be best. Compare two figures. A scientist might ask, what causes depression? We can very well imagine a philosopher turning around and asking the scientist, what is causality? The scientist presupposes a concept of causality in her investigations. She uses this concept in her inquiry. Now she might have a sophisticated concept of causality or she might never have thought much about causality at all, using it in the sort of colloquial and unreflective way that Plato decried when, for example, people like Euthyphro talked about piety. A whole cascade of questions arise when we raise a question like "what is causality?" We can ask whether or not causality exists at all. We can ask how we distinguish between correlation and two events that merely accompany one another from genuine causation. This, for example, was Hume's question. But perhaps most importantly we can ask whether there is only one form of causality or many forms of causality. Is there only one-to-one causation; one cause and one effect? Is there many-to-one causation; or many events conspiring to produce an effect? Is there one-to-many causation; or one event producing a variety of different effects? We can even ask whether causality necessarily moves from past to present or whether there aren't forms of causality that move from future to past! **January 23, 2014 Pluralism and Realism:** multiple-worlds Over at Struggles Forever, Jeremy Trombley has an interesting post up on "the ontological turn" in anthropology or ethnography. I've been meaning to have a discussion with him about this as I think it's an issue many of us are struggling with. For example, the core project of The Democracy of Objects– a proj ect which I think many have missed –is to somehow reconcile some version of social constructivism with a realist ontology capable of making room for ecology (which requires realist and materialist positions as there's a fact of the matter where global warming is concerned) as well as the role played by objective agencies in social assemblages such as technologies, infrastructure, features of geography, local climates, the growth cycles of plants and animals, waste, etc. Maybe we can try to organize some cross-blog event to discuss these issues. I certainly think they're close to the heart of Jeremy, Michael of Archive Fire, Arran James, and a host of others. As an aside, I'm beginning to realize how the different sites of the political I've been outlining– semiopolitics, thermopolitics, oikopolitics (political economy), geopolitics, eropolitics (the politics of sex and desire), biopolitics, and chronopolitics (and I'm sure there are other political sites!) –are drawing me away from traditional Marxism. Assuming that classical Marxism holds that economics or the conditions and relations of production are determinative of all other sites of the political, the various sites of the political that I've been outlining would lead to the conclusion that there is not one determinative base of the political. This would not require committing Marx to flames, but rather of recognizing the phenomenon of overdetermination, or of a variety of different entangled sites of the political. But I digress. First, I find myself wondering what the ontological turn means in ethnography. Is it 1) the investigation of the different ontologies held/proposed by different cultures? E.g., the Aztecs believed that reality was structured in this way, while the Greeks in that way, and the ancient Chinese this way, etc? Or 2) is it an investigation of how real entities– independent of cultural beliefs –influence cultural formations? Or is it a combination of both? A position that I would favor. January 20, 2014 Thoughts on the Social and Political Implications of Correlationism .Lion Mirror Truth be told, as my thought has evolved the issue of correlationism had fallen off the radar for me. Somehow the debate had come to seem too "philosophical" to me, too "scholastic", too remote from what interests me: understanding why social assemblages are organized as they are, how power functions in social assemblages, and what we might do to address that power and change things. Somehow the question of whether or not we can get out of the correlation between thinking and being just came to seem remote from these sorts of issues. Somehow it seemed too epistemological. ASIDE: Numerous discussions over the years have led me to believe that the debate over correlationism is poorly understood (or maybe I just don't understand it). On countless occasions I've heard people say "of course we must relate to things in order to know them." Well yeah, of course! I don't think this is what the critic of correlationism is getting at. It seems to me that correlationism is something more robust than the theses that we must relate to something to know it. Correlationism instead seems to require the theses that thought and being are indiscernible. Put more concretely, the correlationist is someone who argues that we either a) can never tell whether being is merely a construction of our thought (weak correlationism), or b) who argues that thought actually constructs being (strong correlationism). In other words, correlationism is another name for idealism. One can hold that we must relate to something in order to know it without being a correlationist. As an aside I should also add that I am a correlationist about some things. For example, I think money is something constructed by society and is therefore a strong correlationist when it comes to money. At any rate, for a long time I'd become rather indifferent to debates about correlationism and philosophies of access. I had learned the lessons of speculative realism– which I could have also learned, I think, from Deleuze and Guattari, the new materialist feminists, actor-network theorists such as Latour –and had moved on. However, occasionally you come across a tone of phrase that pitches something in a different light. In The Cut of the Real, Katerina Kolozova writes, …the political problem of contemporary philosophy identified by the 'new realists' is, in fact, the product of a more fundamental epistemic problem. In his book After Finitude, Quentin Meillassoux calls this problem 'correlationism' and identifies it as an essentially post-Kantian legacy, which continues to dominate and limit philosophy. As a matter of fact, correlationism lies at the heart of postmodern theory and consists in the premise that thought can only 'think itself,' that the real is inaccessible to knowledge and human subjectivity, and that there is nothing but discursive constructs that fully determine thinking and that are meth0dologically accounted for all the way down. (1

– 2) Thought thinking only itself: Thought only encountering itself. In the jargon of postmodern and poststructuralist lingo, this would be the thesis of infinite semiosis, where signs ("thoughts") only ever relate to other signs. Within this framework, discursivity comes to be the hegemonic framework defining all of being. At the level of politics and social theory more generally, if the correlationist thesis is true the consequences are clear: all social phenomena are discursive and all solutions to social and political problems will be discursive. The sole sphere of the political will be the discursive and all questions of politics will be questions of speech-acts and interpretation. The problem here is not that many theorists recognize that the discursive and semiotic plays an important role in the social and the political. It does and I've repeated this tirelessly. The problem is with what happens when thought or the semiotic becomes a hegemon, an "all", foreclosing our ability to recognize other forms of power. What I've wanted to say is that not all power functions discursively. In my last post and elsewhere I spoke of some other forms of politics: Thermopolitics: The politics surrounding **energy in the form of calories and fuels such as gasoline** and coal, and how our life and our very bodies are structured by energy dependencies and by being trapped in particular distributive networks that render these forms of energy available. I'm being quite literal when I speak of energy, talking about the effects, for example, of the absence of food in certain educational environments on cognition, for example; and am generally hostile to metaphorical extensions of the concept of energy which I see as erasing the dimension of real materiality. Geopolitics: The role that features of natural and built geography such as mountain ranges, rivers, oceans, soil conditions, roads, housing design, etc., play in the form that social relations take and how they impact individual bodies. Chronopolitics: The way in which the structurations of time organize what is possible for us. For example, the structuration of the working day, how much we can say and comprehend at any given time, the impact of things like the invention of the clock, etc. **Oikopolitics: This would be the domain of political economy described so well by Marxists**. So five different types of politics: Semiopolitics (or what currently dominates critical theory), thermopolitics, geopolitics, chronopolitics, and oikopolitics. No doubt there are other sites of the political or political struggle that we could speak of, but this is a good start. Also, it should be obvious that these aren't exclusive domains, but are entangled in all sorts of important ways. For example, something might take place at the level of semiopolitics (speech, law, rhetoric, norms, and communication) that has all sorts of impact at the level of thermopolitics. Congress might decide to cut programs that fund school meal programs. This, in turn, will have a thermodynamic impact on those students that go without the calories they need developmentally and cognitively to function in a particular way. There is an entanglement here of semiopolitical and thermopolitical domains. The young student here has been constrained both at the level of **semiotic phenomena and thermodynamic structures**. The point is that if true, semiotic intervention (speech-acts, protests, interpretations, deconstructions, etc) will not be an appropriate response to all political problems because social formations are not entirely structured by the semiotic. The child in that school does not suffer from a lack of the right signs, but from a lack of calories needed to run the engine of his thought and body. Certainly semiotic interventions might be needed to render that energy available, but it is the energy itself that is at issue and the absence of that energy that forms the spider web entangling him in his position. A correlationist perspective tends to erase this as even being a site of the political. **Larval Subjects January 28, 2014 Ontological Anarché Posted by larval subjects under Uncategorized January 27, 2014 Roden on Pluralism Over at enemy industry Roden has an excellent post up on the pluralism discussion. Check it out here. January 25, 2014 Different Senses of Pluralism and Ontology Posted by larval subjects under Uncategorized Responding to one of my comments over at his blog, Jeremy Trombley:** I have deleted restricted, reformulated some sentences .Kindly bear with me. Intention is to make the discursive enucleation consistent with the subject in question**.** Recourse to epistemology of the quantum mechanics generic and fervor of string theory is a sine qua non for the further comprehension of the theory and ontology .How would the world appear to us if its ontology was that of classical mechanics but every agent faced a restriction on how much they could come to know about the classical state? We show that in most respects it would appear to us as quantum. The statistical theory of classical mechanics, which specifies how probability distributions over **phase space evolve** under Hamiltonian evolution and under measurements, is typically called Liouville mechanics, so the theory we explore here is Liouville mechanics with an epistemic restriction. The particular epistemic restriction we posit as our foundational postulate specifies two constraints. The first constraint is a classical analog of Heisenberg's uncertainty principle; the second-order moments of position and momentum defined by the phase-space distribution that characterizes an agent's knowledge are required to satisfy the same constraints as are satisfied by the moments of position and momentum observables for a quantum state. The second constraint is that the distribution should have maximal entropy for the given moments. Starting from this postulate, authors derive the allowed preparations, measurements, and transformations and demonstrate that they are isomorphic to those allowed in Gaussian quantum mechanics and generate the same experimental statistics. They argue that this reconstruction of Gaussian quantum mechanics constitutes additional evidence in favor of a research program wherein quantum states are interpreted as states of incomplete knowledge and that the phenomena that do not arise in Gaussian quantum mechanics provide the best clues for how one might reconstruct the full quantum theory. I: http://dx.doi.org/10.1103/PhysRevA.86.012103 **Reconstruction of Gaussian quantum mechanics from Liouville mechanics with an epistemic restriction Phys. Rev. A 86, 012103 – Published 10 July 2012 Stephen D. Bartlett, Terry Rudolph, and Robert W. Spekkens.** Deleuze in fact characterizes modes of existence, with their powers and capacities. The answer is this: Deleuze approaches modes of existence, ethically speaking, not in terms of their will, or their conscious decision making power (as in Kant), nor in terms of their interests (as in Marx, for example), but rather in terms of their drives. For Deleuze, conscious will and preconscious interest are both subsequent to our unconscious drives, and it is at the level of the drives that we have to aim our ethical analysis. Here, I would like to focus on two sets of texts on the drives taken, not from Nietzsche and Spinoza, but rather from Nietzsche and Leibniz (Leibniz being one of the first philosophers in the history of philosophy to have developed a theory of the unconscious). The first set of texts comes from Nietzsche's great early book entitled Daybreak, published in July 1881. Nietzsche first approaches the question of the drives by giving us an everyday scenario: "Suppose we were in the market place one day," he writes, "and we noticed someone laughing at us as we went by: this event will signify this or that to us according to whether this or that drive happens at that moment to be at its height in us—and it will be a quite different event according to the kind of person we are. One person will absorb it like a drop of rain, another will shake it from him like an insect, another will try to pick a quarrel, another will examine his clothing to see if there is anything about it that might give rise to laughter, another will be led to reflect on the nature of laughter as such, another will be glad to have involuntarily augmented the amount of cheerfulness and sunshine in the world—and in each case, a drive has gratified itself, whether it be the drive to annoyance, or to combativeness or to reflection or to benevolence. This drive seized the event as its prey. Why precisely this one? Because, thirsty and hungry, it was lying in wait" (D 119). This is the source of Nietzsche's doctrine of perspectivism ("there are no facts, only interpretations"), but what is often overlooked is that, for Nietzsche, it is our drives that interpret the world, that are perspectival—and not our egos, not our conscious opinions. It is not so much that I have a different perspective on the world than you; it is rather that each of us has multiple perspectives on the world because of the multiplicity of our drives—drives that are often contradictory among themselves. "Within ourselves," Nietzsche writes, "we can be egoistic or altruistic, hard-hearted, magnanimous, just, lenient, insincere, can cause pain or give pleasure" (Parkes, pp. 291-292). We all contain such "a vast confusion of contradictory drives" (WP 259) that we are, as Nietzsche liked to say, multiplicities, and not unities. Moreover, these drives are in a constant struggle or combat with each other: my drive to smoke and get my nicotine rush is in combat with (but also coexistent with) my drive to quit. This is where Nietzsche first developed his concept of the will to power—at the level of the drives. "Every drive is a kind of lust to rule," he writes, "each one has its perspective that it would like to compel all the other drives to accept as a norm" (WP 481). DELEUZE AND THE QUESTION OF DESIRE: TOWARD AN IMMANENT THEORY OF ETHICS Daniel W. Smith. **In on a Possible Physical Metatheory of Consciousness Miroljub Dugic et al** show that the modern quantum mechanics, and particularly the theory of decoherence, allows formulating a sort of a physical metatheory of consciousness. Particularly, the analysis of the necessary conditions for the occurrence of decoherence, along with the hypothesis that consciousness bears (more-or-less) well definable physical origin, leads to a wider physical picture naturally involving consciousness. This can be considered as a sort of a psycho-physical parallelism, but on very wide scales bearing some cosmological relevance. Open Systems & Information Dynamics Volume 9, Number 2, 153 (2002) arXiv: quant-ph/0212128. On a broader perspective and background, the theoretical computation of the universe is justified.IN physics and cosmology, digital physics is a collection of theoretical perspectives based on the premise that the universe is, at heart, describable by information, and is therefore computable. Therefore, according to this theory, the universe can be conceived of as either the output of a deterministic or probabilistic computer program, a vast, digital computation device, or mathematically isomorphic to such a device. Digital physics is grounded in one or more of the following hypotheses; listed in order of decreasing strength. The universe or reality: is essentially informational (although not every informational ontology needs to be digital); is essentially computable (the pancomputationalist position); can be described digitally; is in essence digital; is itself a computer (pancomputationalism); is the output of a simulated reality exercise. Following Jaynes and Weizsäcker, the physicist John Archibald Wheeler wrote the following: [...] it is not unreasonable to imagine that information sits at the core of physics, just as it sits at the core of a computer. (John Archibald Wheeler 1998: 340) It from bit. Otherwise put, every 'it'—every particle, every field of force, even the space-time continuum itself—derives its function, its meaning, its very existence entirely—even if in some contexts indirectly—from the apparatus-elicited answers to yes-or-no questions, binary choices, bits. 'It from bit' symbolizes the idea that every item of the physical world has at bottom—a very deep bottom, in most instances—an immaterial source and explanation; that which we call reality arises in the last analysis from the posing of yes–no questions and the registering of equipment-evoked responses; in short, that all things physical are information-theoretic in origin and that this is a participatory universe. (John Archibald Wheeler 1990: 5) David Chalmers of the Australian National University summarised Wheeler's views as follows: Wheeler (1990) has suggested that information is fundamental to the physics of the universe. According to this 'it from bit' doctrine, the laws of physics can be cast in terms of information, postulating different states that give rise to different effects without actually saying what those states are. It is only their position in an information space that counts. If so, then information is a natural candidate to also play a role in a fundamental theory of consciousness. We are led to a conception of the world on which information is truly fundamental, and on which it has two basic aspects, corresponding to the physical and the phenomenal features of the world. (Wikipedia). **Participatory consciousness forms the bastion, pillar, post, stylobate and fulcrum of the redressal measures and corrective steps taken for circumvention of many problems, identified and unidentified, spread widest commonalty. Anne Baring's sententious and pithy article will be good to have a timely outlook.** I would like to open my contribution to this meeting with the words of Ken Wilber that I quoted in the first Millennium Symposium: 'The secret impulse of life is towards greater consciousness. Maybe the evolutionary sequence is from matter to body, to mind, to soul, to spirit - each transcending and including, each with a greater depth and greater consciousness and wider embrace' Ken Wilber, and with these from Rupert Sheldrake's contribution to the same meeting: "It is possible to make quite a good case that the sun could be conscious and if the sun, then why not the stars? Why not the galaxies? Why should there not be galactic minds? And if they communicate with each other then the distances are far too great for light to be the medium of transmission. We are into inter-galactic telepathy." After many decades of study, I know of only one diagram in all religious traditions that can adequately explain these statements; that can give us both a blue-print of the many levels of consciousness and a route-map to help us reach beyond our present level of understanding. I would like to introduce a diagram of the four worlds of Kabbalah to illustrate the theme that spirit has brought these four worlds into being and that we, living in the fourth and manifest world know nothing of the existence of the other three invisible ones. It is the clearest diagram I know of that can explain to us the multi-levelled structure of consciousness and our place in the great chain of being. We are indeed, as Wilbur suggests, evolving from matter to body, to mind, to soul, to spirit but where have we come from? It is possible that, as participants in the emanation of spirit into manifest life, we have also come from spirit to soul, to mind, to body, to matter. Everything, from the immense galactic energies to the minute forms of matter participates in one life, is generated from one creative spirit. There is nothing outside this life, this spirit. This diagram suggests that truth is not an article of faith but the experience of participating in the undiscovered reality of what has brought us into being. We cannot know truth until we have entered into communion with that reality. Continuing in similar vein **Michel Bitbol dilates upon the dialectic deliberation and polemical argumentation between** hermeneutists and eliminativists. When he formulated the program of Neurophenomenology, Francisco Varela suggested a balanced methodological dissolution of the "hard problem" of consciousness. He shows that his dissolution is a paradigm which imposes itself onto seemingly opposite views, including materialist approaches. I also point out that Varela's revolutionary epistemological ideas are gaining wider acceptance as a side effect of a recent controversy between hermeneutists and eliminativists. Finally, he emphasizes a structural parallel between the science of consciousness and the distinctive features of quantum mechanics. This parallel, together with the former convergences, point towards the common origin of the main puzzles of both quantum mechanics and the philosophy of mind: neglect of the constitutive blindspot of objective knowledge. Phenomenology and the Cognitive Sciences Phenomenology and the Cognitive Sciences **Phenomenology and the Cognitive Sciences 2002, Volume 1, Issue 2, pp 181-224 Science as if situation mattered Michel Bitbol.** Caroline Williams investigated affective density of the political and its effect on our understanding of political subjectivity. Taking up Spinoza's challenge to think about affect beyond corporeal embodiment, he argues that there is a modality of affectivity that cannot simply be inscribed within the borders of subjectivity. theorising affect as an impersonal force anchored in a relational ontology that gives due recognition to the circulation of affects, as well as to their ambivalent structure in creating sites of identification, and he utilises this ontology to reflect on the dynamic of the political and the shape of political subjectivity. Williams argues that Spinoza's philosophy (through ideas of conatus and imagination) offers the conceptual resources to reconfigure the composition of affective subjectivity as a transindividual social bond and as an unconscious dynamic of ethico-political existence. **Subjectivity (2010) 3, 245–262. doi:10.1057/sub.2010.15 Affective processes without a subject: Rethinking the relation between subjectivity and affect with Spinoza Caroline Williams** Phenomenological Time bears ample evidence and infallible observatory and apodictic evidence albeit with a sense of chagrined circumvention and defeated disgruntlment circularity of both psychological and phenomenological interpretations of art which are sometimes insightful, but most often work on the logic of cyclical time and unavoidable drives and representations played out as a 'natural' order: where 'men can't avoid being boys' a circularity which valorizes a helplessness/truthfulness conundrum. One begins with a classical phenomenological fallacy with Duchamp's Fountain, does the urinal keep returning or do we keep returning to the urinal? Put in this way, it is a male question, something that phenomenology conveniently conceals when positing the "I", or indeed, the "we". But we must be careful not to simply assume that the phenomenological first person is white, heterosexual, able-bodied and male, providing a foundation upon which knowledge should be based as a universal condition. Deleuze's second critique of time is linked to Kant. This model of time extends not only to phenomenology but to the phenomenological interpretation of art and is seen as a straight line. In the Critique of Pure Reason, Kant cuts up circular time and reassembles it as a series of sensory experiences which memory processes and which constitute subjectivity. Whereas the circular model of time (and interpretation) inscribes fatalism into the subject and the world, the phenomenological method is in danger of solipsism, where the subject constitutes the world. Much of embodied philosophy and enactivist theories of cognition go down this line with a plethora of art historical analyses by the likes of Rosalind Krauss, Michael Fried and others taking the lead from Merleau-Ponty. These approaches successfully challenge the **homunculus model of a Cartesian mind-body** dualism where there is a supervisor in the mind who processes experience and even consciousness and to whom all representations are directed. But phenomenology is mainly concerned with perceptual consciousness, the processing of colors, shapes, forms, motion in art and the world. The senses and sensorimotor processes are the fundamental pathways by which the interior is connected to the exterior in a chiasm of self-constitution in the world. The problem with this is that we explore the art through our sense perceptions, and what does art reveal to us?—our sense perceptions! Such solipsistic approaches have real problems relating complex and abstract conceptual production to bodily and sensorimotor contingencies, and they nearly always posit the subject as the site and object of discovery in the world. To be fair, phenomenology has moved on to rather more sophisticated models of intersubjectivity, taking into account the specificities of different kinds of bodies and ways of being beyond the white, male heterosexual as the common denominator, yet many naïve approaches to art perpetuate the notion that perceptual, rather than conceptual processes and evolutionary neural patterns are primary, fundamental ways to understand the art experience In fact, these aspects are only part of art production and reception, aspects which are often filtered out or made known to us in order for us to parody such trigger responses, as in much of Duchamp's work, which holds in contempt such retinal approaches to art. If we take the **subject of abstract expressionism** in the 1950s or later minimalist art, art history, teaching and interpretation still insists on putting the act of perceiving as fundamental to the constitution not only of the phenomenological first person but also of art itself. The male act of usually standing up, which consists of directing a stream with the hand(s) into a container or on a flat surface, sand or snow in order to leave patterns and traces (the usual child's prank) underlies the logic of macho 1950s Abstract Expressionist culture, especially that of Jackson Pollock, so effectively parodied by Carolee Schneeman's Vagina Scroll, 1975. Here, painting or writing is a kind of a discharge which invests the **object and space with** the phenomenological "I", disciplined by existential struggle and reflected back by the traces, signatures and gestures left behind in the work of art, rediscoverable as an element in the making of other subjectivities.It is precisely this kind of solipsism which is blind to the art event as something well in excess of re-establishing habits of subjective self-identity through the production and interpretation of art. The attempt to reinforce a phenomenological identity upon the event by personalizing sense experience is unable to see art as something which remodels the phenomenological 'I' and neural plasticity itself. We learn new technologies and redraw our neural pathways through such new and spontaneous experiences which draw us into intersubjective worlds. Duchamp's Fountain and Deleuze's Repetition and Différence Grégory Minis sale (I have made some changes) The relation of different groups to deconstruction is settled by its relation to groups. An American enthusiast--one who has had a role in the development of our affection for Derrida--notices that the motivational chains are phobically driven by concerns with social scale. Richard Rorty: "He wants to figure out how to break with the temptation to identify himself with something big. . . ."(10) And: "So I take Derrida's importance to lie in his having had the courage to give up the attempt to unite the private and the public, to stop trying to bring together a quest for private autonomy and an attempt at public resonance and utility. He privatizes the sublime, having learned from the fate of his predecessors that the public can never be more than beautiful."(11) Notice is made here of what is indeed the telling feature. Levinas is praised, for example, for his alarm when "the social will [is] sought in an ideal of fusion . . . the subject losing himself in a collective representation, in a common ideal. . . . It is the collectivity which says 'us,' and which, turned toward the intelligible sun, toward the truth, experience, the other at his side and not face to face with him. The tellingly titled D'un ton apocalyptique contains passages that are particularly excited: These people situate themselves outside the ordinary, but they have in common this: they describe themselves as having an immediate and intuitive relation with mystery. And they want to attract, to seduce, and lead others to the mystery, through mystery. This agogic function of the leader of men, of the duce, of the Führer, of the leader, places him above the crowd that he manipulates with the aid of a small numbers of adepts joined together in a sect with a secret language, a clique or a small party with its ritualized practices. The mystifiers pretend to have exclusive access to the privilege of a secret mystery. . . . The revelation or the unveiling of the secret is something that they jealously reserve for themselves. Jealousy is here a major characteristic. There is not narcissism and non-narcissism; there are narcissisms that are more or less comprehensive, generous, open, extended. What is called non-narcissism is in general but the economy of a much more welcoming, hospitable narcissism, one that is much more open to the experience of the other as other. I believe that without a movement of narcissistic reappropriation, the relation to the other would be absolutely destroyed; it would be destroyed in advance. The relation to the other--even if it remains asymmetrical, open, without reapporpriation--must trace a movement of reappropriation in the image of oneself for love to be possible, for example. Love is narcissistic. Beyond that, there are little narcissisms, there are big narcissisms. . . .(23) **Justice of the Pieces Deconstruction as a Social Psychology Douglas Collins** Sabine Wilke cogently argues for the rise of the aesthetic dimension in philosophical writing by showing how the metaphorical and poetic style of Heidegger, the principles of phrase configurations with Adorno, or the topographic writing of derrida replace through their very form something what traditionally would have been subject to discursive exposure The concern shifts from telling to showing, showing first and foremost that something remains untold. An exemplary book in this aesthetic drive is Avital Ronell's Telephone Book where the playful layout and explicit break with traditional design interrupt the sequential logic of the paragraphs thereby performing the very argument at stake: open up new circuits of meaning and signification. The engagement with form and publishing formats is only consequential since media theory as exposed by Walter J. Ong, Eric A. Havelock, Parry Miman or Marshall McLuhan besides many others made it clear that different communication technologies condition the mode of thought of a given culture The

fractals of Benoit Mandelbrot or the butterfly shaped Lorenz attractor are the popular icons of this turn in the sciences. For communication studies and philosophy, Vilém Flusser was one of the pioneer thinkers reflecting the rise of what he called "techno-images." The photograph is the paradigmatic case which condenses the whole crises of Western thought and culture on its grainy surface. It subverts the linear logic of writing.6 Flusser's central diagnosis detects a shift from the grand narratives associated with the literate mind and Modernity towards creating and envisioning the world through image based practices. Writing himself in a succinct, visually inspired style, Flusser contents that the web of meaning, spun throughout the centuries by our textual practices, has become transparent. We discover the void between the letters through which the world escapes: "We are alienated from the world of text, precisely because we see through them as our own product."7 As a consequence we are confronted with a world of dissociated facts and information bits. Flusser hails this fragmented world as the advent of the zero dimensional point-universe that will provide the new raw material for our image based practices. Techno-images are nothing else than a conscious, inherently artistic drawing-together of point-elements as exemplified first and foremost by the silver-grains of the photograph but also by more recent pixel based techno-images. Similar to blueprints, designs or statistical curves, the weather map for example visualizes and contracts a tremendous amount of meteorological data from widely distributed stations into a single image of high- and low pressure
areas, temperatures, wind speeds, etc. Techno-images "compute" in this sense the universe of unimaginable, abstract information-bits into a concrete surface – the image. Echoing Paul Feyerabend, these image practices have to be understood as creative practices where the truth of scientific models has been replaced by its aesthetic quality **Aesthetics, Writing, Networked Computers Jörg Muller Dissertation Submitted to the Division of Media and Communications of The European Graduate School in Candidacy for the Degree of Doctor of Philosophy**
Lothar Schäfer (1) and Sisir Roy (2) in Quantum Reality, the Importance of Consciousness in the Universe, the Discovery of a Non-Empirical Realm of Physical Reality, and the Convergence with Ancient Traditions of Indian and Western Philosophy investigate metaphysical aspects that include 1) the discovery of a non-empirical part of physical reality in a realm of potentiality; 2) the emanation of the empirical world out of a realm of non-material forms; 3) the discovery that the nature of physical reality is that of an indivisible Wholeness – the One; and 4) panpsychism: the possibility that the One is aware of its processes like a Cosmic Consciousness. The convergence of powerful traditions of seemingly disparate cultures is particularly important to point out in the present process of globalization, when a unifying view is needed to avoid controversy and conflict. To quote them in extenso : This is the nonlocality of the quantum world. Menas Kafatos and Robert Nadeau (1990) have drawn a remarkable conclusion from this phenomenon: If reality is nonlocal, the nature of the universe is that of an undivided wholeness. Because our consciousness has emerged from this wholeness and is part of it, it is possible to conclude that an element of consciousness is active in the universe: a Cosmic Consciousness. Pre-reflective self-consciousness is pre-reflective in the sense that (1) it is an awareness we have before we do any reflecting on our experience; (2) it is an implicit and first-order awareness rather than an explicit or higher-order form of self-consciousness. Indeed, an explicit reflective self-consciousness is possible only because there is a pre-reflective self-awareness that is an on-going and more primary self-consciousness. Although phenomenologists do not always agree on important questions about method, focus, or even whether there is an ego or self, they are in close to unanimous agreement about the idea that the experiential dimension always involves such an implicit pre-reflective self-awareness. In line with Edmund Husserl (1959, 189, 412), who maintains that consciousness always involves a self-appearance (Für-sich-selbst-erscheinens), and in agreement with Michel Henry (1963, 1965), who notes that experience is always self-manifesting, and with Maurice Merleau-Ponty who states that consciousness is always given to itself and that the word 'consciousness' has no meaning independently of this self-givenness (Merleau-Ponty 1945, 488), Jean-Paul Sartre writes that pre-reflective self-consciousness is not simply a quality added to the experience, an accessory; rather, it constitutes the very mode of being of the experience: This self-consciousness we ought to consider not as a new consciousness, but as the only mode of existence which is possible for a consciousness of something (Sartre 1943, 20 [1956, liv]). The notion of pre-reflective self-awareness is related to the idea that experiences have a subjective 'feel' to them, a certain (phenomenal) quality of 'what it is like' or what it 'feels' like to have them. As it is usually expressed outside of phenomenological texts, to undergo a conscious experience

necessarily means that there is something it is like for the subject to have that experience (Nagel 1974; Searle 1992). This is obviously true of bodily sensations like pain. But it is also the case for perceptual experiences, experiences of desiring, feeling, and thinking. There is something it is like to taste chocolate, and this is different from what it is like to remember what it is like to taste chocolate, or to smell vanilla, to run, to stand still, to feel envious, nervous, depressed or happy, or to entertain an abstract belief. Yet, at the same time, as I live through these differences, there is something experiential that is, in some sense, the same, namely, their distinct first-personal character. All the experiences are characterized by a quality of mineness or for-me-ness, the fact that it is I who am having these experiences. All the experiences are given (at least tacitly) as my experiences, as experiences I am undergoing or living through. All of this suggests that first-person experience presents me with an immediate and non-observational access to myself, and that consequently (phenomenal) consciousness consequently entails a (minimal) form of self-consciousness. To put it differently, unless a mental process is pre-reflectively self-conscious there will be nothing it is like to undergo the process, and it therefore cannot be a phenomenally conscious process. The mineness in question is not a quality like being scarlet, sour or soft. It doesn't refer to a specific experiential content, to a specific what; nor does it refer to the diachronic or synchronic sum of such content, or to some other relation that might obtain between the contents in question. Rather, it refers to the distinct givenness or the how it feels of experience. It refers to the first-personal presence or character of experience. It refers to the fact that the experiences I am living through are given differently (but not necessarily better) to me than to anybody else. It could consequently be claimed that anybody who denies the for-me-ness of experience simply fails to recognize an essential constitutive aspect of experience. Such a denial would be tantamount to a denial of the first-person perspective. It would entail the view that my own mind is either not given to me at all — I would be mind- or self-blind — or is presented to me in exactly the same way as the minds of others. There are also lines of argumentation in contemporary analytical philosophy of mind that is close to and consistent with the phenomenological conception of pre-reflective self-awareness. Alvin Goldman provides an example: [Consider] the case of thinking about x or attending to x. In the process of thinking about x there is already an implicit awareness that one is thinking about x. There is no need for reflection here, for taking a step back from thinking about x in order to examine it…When we are thinking about x, the mind is focused on x, not on our thinking of x. Nevertheless, the process of thinking about x carries with it a non-reflective self-awareness (Goldman 1970, 96). A similar view has been defended by Owen Flanagan, who not only argues that consciousness involves self-consciousness in the weak sense that there is something it is like for the subject to have the experience, but also speaks of the low-level self-consciousness involved in experiencing my experiences as mine (Flanagan 1992, 194). As Flanagan quite correctly points out, this primary type of self-consciousness should not be confused with the much stronger notion of self-consciousness that is in play when we are thinking about our own narrative self. The latter form of reflective self-consciousness presupposes both conceptual knowledge and narrative competence. It requires maturation and socialization, and the ability to access and issue reports about the states, traits, dispositions that make one the person one is. To claim that every kind of self-consciousness is conceptual is overly cognitive. Bermúdez (1998), to mention one further philosopher in the analytic tradition, argues that there are a variety of **nonconceptual forms of self-consciousness** that are "logically and ontogenetically more primitive than the higher forms of self-consciousness that are usually the focus of philosophical debate" (1998, 274; also see Poellner 2003). This growing consensus across philosophical studies supports the phenomenological view of pre-reflective self-consciousness. (References: Stanford Encyclopedia, Post Modersnist Theories, Internet Encyclopedia of Philosophy) Korzybski pointed out that there are two ways to slice easily through life; to believe everything or to doubt everything. Both ways save us from thinking. So, from time to time you have to give yourself a Virtual Reality Check. The hallmark of postmodern philosophy has been disbelief or skepticism of all "metanarratives," or translations of reality. Postmodernism has even turned its profound skepticism on such important humanist concepts as "objective truth" and reason.Yet, for a deconstructionist postmodern society, individually we are still riddled with superstition and gullibility, and open to manipulation through our belief systems as any politician, philosopher, clergy, or salesperson will attest. Further, most people are painfully naive when it comes to even the simplest scientific understanding. Most of us don't have a clue about the fundamental nature of physical reality or our own psychological nature, and our ability to be fooled by our senses and mind, or methods of social and technological persuasion. We may think we know, but the penetration is deeper than we dare imagine. Nature rejects the naiveté that seeks absolute truth. We are beginning to realize, individually and culturally, that "realities" are all human constructions. The task becomes one of "catching ourselves in the act" of creating our own "reality" from the flow of events. Human truth is always an engagement of mind with experience.. We don't need to fear the collapse of our personalistic belief system (the "box" we live in), nor our belief in absolute truth. **A strong desire to engage in the "quest for uncertainty" complements our anxiety that perhaps there is no absolute, objective ground to reality**. The warrant of Truth is ever elusive when we deconstruct the foundational justifications of our convenient notions about the way the world works. It is easy to confuse what is actually the creation of beliefs with the "discovery of Truth," a common goal of science and theology. Science offers no ontological Scientific Picture of the World but substitutes a number of applied theories as meta-theory. It's close, powerful and useful: it 'works' and allows use to do work. But the still mysterious "true" metatheory may reveal the basis of consciousness. But who knows when we will lift that veil? Permeating the living reality of our culture are certain contagious notions, fads and trends that have the ability to influence the way we think about the nature of Reality and ourselves. Some of them are toxic and can consume you; others are just whims of pop culture infectious and benign as the common cold. **Jung** described the concept of psychic contagion by certain archetypal forces inherent in the human psyche, which manifest in our spiritual lives and belief systems. He spoke of both conscious and unconscious contamination. Notions like this range from simple superstitions to scientific concepts, to urban myths. Notions sweep through our culture and insinuate themselves within its fabric, as fads, whether they are "real" or not, they can be influential. They mood alter us, make us feel we belong. An analysis of these notions is useful in distinguishing a common human phenomenon from any potential "alien influence" which may or may not be exerted on us from an unknown source. **Strange Attractors: Transference, Holography, and an Archetype Burke, J. (2003). Strange Attractors: Transference, Holography, and an Archetype (Doctoral dissertation, Pacifica Graduate Institute, 2003).** In consideration to the Nobel Proze for Chemistry this year(2014), a stability nalysis of the proble in to single molexues would be a contemporaneous question that has to be taken cognisace of and given importance to . Determination of molecular structure by geometry optimization became routine only after efficient methods for calculating the first derivatives of the energy with respect to all atomic coordinates became available. Evaluation of the related second derivatives allows the prediction of vibrational frequencies if harmonic motion is estimated. More importantly, it allows for the characterization of stationary points. The frequencies are related to the eigenvalues of the Hessian matrix, which contains second derivatives. If the eigenvalues are all positive, then the frequencies are all real and the stationary point is a local minimum. If one eigenvalue is negative (i.e., an imaginary frequency), then the stationary point is a transition structure. If more than one eigenvalue is negative, then the stationary point is a more complex one, and is usually of little interest. When one of these is found, it is necessary to move the search away from it if the experimenter is looking solely for local minima and transition structures. The total energy is determined by approximate solutions of the time-dependent Schrödinger equation, usually with no relativistic terms included, and by making use of the Born–Oppenheimer approximation, which allows for the separation of electronic and nuclear motions, thereby simplifying the Schrödinger equation. This leads to the evaluation of the total energy as a sum of the electronic energy at fixed nuclei positions and the repulsion energy of the nuclei. Notable exceptions are certain approaches called direct quantum chemistry, which treat electrons and nuclei on a common footing. Density functional methods and semi-empirical methods are variants on the major theme. **Orlando Alvarez** discusses Polyakov's quantization of the string in the presence of a boundary allowing for an arbitrary topology for the world sheet. In addition to the dynamical conformal factor discovered by Polyakov, there are a finite number of new degrees of freedom if the surface is more complicated than a sphere or a disc. The quantization of the Liouville theory in an arbitrary topology is also discussed. A one-loop calculation shows that the model is renormalizable if one performs a mass renormalization and an additive field renormalization. The renormalization group equations have a perturbative infrared unstable fixed point in all topologies. Copyright © 1983 Published by Elsevier B.V. **Nuclear Physics B Volume 216, Issue 1, 25 April 1983, Pages 125–184 Theory of strings with boundaries: Fluctuations, topology and quantum geometry Orlando Alvarez DOI: 10.1016/0550-3213(83)90490-X**

Quantum geometry (the modern loop quantum gravity involving graphs and spin-networks instead of the loops) provides microscopic degrees of freedom that account for black-hole entropy. However, the procedure for state counting used in the literature contains an error and the number of the relevant horizon states is underestimated. In our paper a correct method of counting is presented by **Marcin Domagala and Jerzy Lewandowski.** Results lead to a revision of the literature of the subject. It turns out that the contribution of spins greater than 1/2 to the entropy is not negligible. Hence, the value of the Barbero–Immirzi parameter involved in the spectra of all the geometric and physical operators in this theory is different than previously derived. Also, the conjectured relation between quantum geometry and the black-hole quasi-normal modes should be understood again. **Marcin Domagala and Jerzy Lewandowski 2004 Class. Quantum Grav 21 5233 doi:10.1088/0264-9381/21/22/014 Black-hole entropy from quantum geometry** Quantum geometry predicts that a universe evolves through an inflationary phase at small volume before exiting gracefully into a standard Friedmann phase. This does not require the introduction of additional matter fields with ad hoc potentials; rather, it occurs because of a quantum gravity modification of the kinetic part of ordinary matter Hamiltonians. Authors draw the cognizance of application of the same mechanism that can explain why the present day cosmological acceleration is so tiny. DOI: http://dx.doi.org/10.1103/PhysRevLett.89.261301 **Inflation from Quantum Geometry Phys. Rev. Lett 89, 261301 – Published 12 December 2002 Martin Bojowald** The loop quantum cosmology of the closed isotropic model is studied with special emphasis on a comparison with traditional results obtained in the Wheeler-DeWitt approach by **Martin Bojowald** .Investigation includes the relation of the dynamical initial conditions to boundary conditions such as the no-boundary or the tunneling proposal and a discussion of inflation from quantum cosmology. **DOI: http://dx.doi.org/10.1103/PhysRevD.67.124023 Loop quantum cosmology, boundary proposals, and inflation Phys. Rev. D 67, 124023 – Published 23 June 2003 Martin Bojowald and Kevin Vandersloot** In loop quantum cosmology, the universe avoids a big bang singularity and undergoes an early and short super-inflation phase. During super-inflation, non-perturbative quantum corrections to the dynamics drive an inflaton field up its potential hill, thus setting the initial conditions for standard inflation. **Shinji Tsujikawa et al** show that this effect can raise the inflaton high enough to achieve sufficient e-foldings in the standard inflation era. They also analyse the cosmological perturbations generated when slow-roll is **violated after super-inflation** and show that loop quantum effects can in principle leave an **indirect signature** on the largest scales in the CMB, with some loss of power and running of the spectral index. **Shinji Tsujikawa et al 2004 Class. Quantum Grav 21 5767 doi:10.1088/0264-9381/21/24/006 Loop quantum gravity effects on inflation and the CMB Quantum geometry from quantum information** is the study of **Florian Girelli and Etera R Livine .**Loop quantum gravity defines the quantum states of space geometry as spin networks and describes their evolution in time. We reformulate spin networks in terms of harmonic oscillators and show how the holographic degrees of freedom of the theory are described as matrix models. This allows us to make a link with non-commutative geometry and to look at the issue of the semi-classical limit of loop quantum gravity from a new perspective. This work is thought of as part of a bigger project of describing quantum geometry in quantum information terms. **Florian Girelli and Etera R Livine 2005 Class. Quantum Grav 22 3295 doi:10.1088/0264-9381/22/16/011 Reconstructing quantum geometry from quantum information: spin networks as harmonic oscillators.** Quantum geometric mechanics is the topic of study by **Dorje C. Brody Lane P. Hughston** establishing a clear relation between the quantum mechanics and quantum geometry and also the entangled states. The manifold of pure quantum states can be regarded as a complex projective space endowed with the unitary-invariant Fubini–Study metric. According to the principles of geometric quantum mechanics, the physical characteristics of a given quantum system can be represented by geometrical features that are preferentially identified in this complex manifold. Here we construct a number of examples of such features as they arise in the state spaces for spin, spin 1, spin and spin 2 systems, and for pairs of spin systems. A study is then undertaken on the geometry of entangled states. A locally invariant measure is assigned to the degree of entanglement of a given state for a general multi-particle system, and the properties of this measure are analysed for the entangled states of a pair of spin particles. With the specification of a quantum Hamiltonian, the resulting Schrödinger trajectories induce an isometry of the Fubini–Study manifold, and hence also an isometry of each of the energy surfaces generated by level values of the expectation of the Hamiltonian. For a generic quantum evolution, the corresponding Killing trajectory is quasiergodic on a toroidal subspace of the energy surface through the initial state. When a dynamical trajectory is lifted orthogonally to Hilbert space, it induces a geometric phase shift on the wave function. The uncertainty of an observable in a given state is the length of the gradient vector of the level surface of the expectation of the observable in that state; a fact that allows us to calculate higher orders corrections to the Heisenberg relations. A general mixed state is determined by a probability density function on the state space, for which the associated first moment is the density matrix. The advantage of a general state is in its applicability in various attempts to go beyond the standard quantum theory, some of which admit a natural phase-space characterization. **Journal of Geometry and Physics Volume 38, Issue 1, April 2001, Pages 19–53 Geometric quantum mechanics Dorje C. Brody Lane P. Hughston DOI: 10.1016/S0393-0440(00)00052-8** Expansion (unmesa) of [consciousness] or the creative intuition {pratibha) is (=) [experienced] in the interval which divides two [moments] of differentiated perception (vikalpa) It is here that they arise and disappear. The Sastras and Agamas proclaim with reasoned argument that it is (=) free of thought-constructs {Nirvikalpa) and precedes (e) Path to Liberation all mental representations of any object. None can deny that a gap exists between perceptions insofar as two moments of thought are (=) invariably divided. This [gap] is (=) the undifferentiated unity of all the countless manifestations. Similarly, in the outer more objective sphere, where change consists (e) of the alterations in the configurations of manifest appearances (Abhasa\ the transition from one to (e&eb) another corresponds to (e&eb) a phase of pure luminosity that marks (eb) the beginning of one form and the end of another. The world of manifestation and differentiated perceptions (Yikalpa) thus extends from one Centre to (eb) the next. **What is meant again is the realisation or the evolution of individual consciousness or general ledger to be the cosmic general ledger is the sole criterion for the Satchidananda state where all dualities cease** Although it is never in fact divorced from (e) the subject who resides there, the ignorant fail (e) to grasp this fact and so, cut off from (e) the Centre, the world of objectivity becomes (=) for them the sphere of Maya. Bhagavatotpala quotes the Light of Consciousness amvitprakdsa): This ever pure experience (suddhanubhava) is variegated by (e) each form [revealed within it] Even so it remains unstained (nirmala) when moving to another. Just as a cloth which is naturally white, once dyed, cannot (e) change colour without [first] becoming white again, similarly the pure power of awareness, (citi) once coloured by (e) form, is pure [again] at the Centre where that form is (=) abandoned and from whence it proceeds to (e&eb) another. In his Essence of Vibration (Spandasarpdoha), K§Emaraja explains that the rise and fall of every individual perception in the field of awareness is (=) a specific pulsation of consciousness. This is exactly the individual general ledger transaction lifted to the transaction in cosmic general ledger. During The Initial Instant Of Perception, T Consciousness Is Manifestly Apparent And The Yogi, Participating In Its Plenitude, Observes The Outer World Without Being Attached To Any Particular Divine Body And Sacred Circle Of The Senses Singling It Out From Any Other, Like A Man Who Observes A City From A High Mountain Peak. He Sees The Outer World Reflected Within His Consciousness Free Of Thought-Constructs And So 'Stamps* The Outer On The Inner While Absorbing The Object And Means Of Knowledge In The Pure Subject Which Grasps Them As The Expansion Of His Own Nature. K§Emaraja Says: By Penetrating Into Bhairavimudra, The Yogi Observes The Vast Totality Of Beings Rising From, And Dissolving Into, The Sky [Of Conscious- Ness], Like A Series Of Reflections Appearing And Disappearing Inside A Mirror. Through The Practice Of Bhairavimudra The Yogi Realises That He Is The Substratum Consciousness (Adhisfhatr) Which Both Underlies And Is The Essence Of All Things. He Discovers That Phenomena Have No Independent Existence Apart From Him And So Are, In This Sense, Void. At The Same Time, He Realises That Because All Things Are Consciousness, They Are Far From Unreal. He Views The Outer World Yet Sees It Not. Beyond Both Voidness And Non-Voidness He Penetrates Into The Supreme Abode (Pararn Padam) Of Siva's Consciousness. [The Powers Of The Senses] Endowed With The Attributes Of The Great Union [Between Subject And Object] Whose Form Is The Wakening Of Man's Spiritual Potential (Kuntfalinf), Fill [With Consciousness] The Outer Clatter Of Diversity (Bhedatfambara) Born Of Its Intense Power And Are Then Established In The Unobscured Abode Of The Void Of Consciousness To Shine [There] Eternally. Thus Residing Beyond Being And Non-Being, The Sole Protector Of The Unity Which Is Tranquil And Expanding [Consciousness], Whose Glory Is All-Embracing And Form Unobscured, Is Called Bhairavimudra. Through The Practice Of Bhairavimudra, The Yogi Unites The Universal Vibration Of T Consciousness With The Individual

Pulsation Of Objectivised 'This' Consciousness. The Two Aspects Of Consciousness Are Now In A State Of Equilibrium Like The Two Pans Of An Evenly Weighed Balance And The Yogi Experiences The Pure Knowledge (Suddhavidya) That: 'I Alone Am All Things'. Thus Becoming The Master Of The Wheel Of Energies He Is Free, Like Siva, To Create And Destroy. When [The Yogi] Is Well Established, Without Wavering, Solely In The Integral Egoity Of His Authentic Nature, The Spanda Principle, And Is Absorbed In Contemplation (Samavisfa), He Becomes One With It The Doctrine Of Vibration (Tanmaya). Then . . . Dissolving And Creating The Universe By Means Of His Introverted And Extroverted Absorption, He Destroys And Creates All Things Out Of Sarikara, His Innate Nature. [Thus] He Assumes The State Of The Universal Experiencer And Having Absorbed All That Is To Be Experienced From [The Grossest Level] — Earth — To (The Subtlest) — Siva — He Reaches The State Of The Supreme Subject By Progressively Recognising [His Identity With Him]. Thus, Introverted And Extroverted Absorption Both Lead To The Recognition Of The Pulsation (Spanda) Of One's Own Consciousness. This Is Where Individual General Ledger Becomes Cosmic General Ledger. At The Level Of Consciousness Corresponding To Siva's Basic State (Saryibhavdvastha), The Alternation From Inner To Outer Is Instantaneously Resolved Into The Vibration Of His Nature. When The Yogi Finally Comes To Be Constantly Aware Of This Reality, His Enlightenment Is Full And Perfect. Freed Of All Means (Anupaya) And Delighting In The Power Of His Bliss (Anandasakti), He Knows And Does Whatever He Pleases. The Yogi Seeking Self-Realisation Must Acquire Mastery Over This Movement. Ksemaraja Stresses That The Doctrine Of Vibration Teaches That Liberation Can Only Be Achieved By First Withdrawing All Sense Activity In Introverted Contemplation (Nimilanasamadhi) To Then Experience The 'Great Expansion' (Mahdvikdsd) Of Consciousness While Recognising This To Be A Spontaneous Process Within It. This Is Done Through The Practice Of Kramamudra. A Passage From The Now Lost Kramasiitra Explains: Although The Adept's Attention [May Be] Outwardly Directed, He Enjoys Contemplative Absorption Through The Introverted Aspect Of Kramamudra. Initially He Turns Inward From The Outside World And [Then] From Within [Himself] He Exits Into The Outer World Under The Influence Of His Absorption. There Is No Necessity Of Any Glorification Or Mortification Here. It Is Just Like Joining A Job And Retiring And Realising All That Happened Is Just By His Own Effort And Nothing Else. Thus The Sequence (Krama) In This Attitude (Mudra) [Ranges Through] Both Inner And Outer. The Yogi Must Pervade The Surface Level Of Awareness (Yyutthana) With The Same Bliss He Experiences Plunging Into The Depths Of Con-Templative Absorption (Samadhi). Note Here That Samadhi Is A Death Like State And Still Being Matter And Information Stored You Experience Consciousness. Submerging Himself And Emerging Repeatedly From Samadhi, He Eventually Recognises That The Unity Of Consciousness Pervades Both States: The Best Of Yogi's, Who Has Achieved A State Of Complete Absorption Even When Risen From Meditation, [Inwardly] Vibrating Like A Drunkard In Blissful Inebriation From The After-Effects Of The Nectar Of Con- Templation, Sees All Things Dissolving In The Sky Of Consciousness Like A Cloud In The Autumn Sky. He Plunges Repeatedly Within Himself Divine Body And Sacred Circle Of The Senses And Becomes Aware Of His Identity With Consciousness By The Practice Of Introverted Contemplation. Thus Even When He Is Said To Have Risen From Absorption, He Is One With [His] Experience Of It. Ksemaraja Goes On To Explain That This Practice Is Called 'Mudra' Because It Both Fills The Adept With Bliss (Mud) And Is Itself The Bliss Of Consciousness. Moreover, It Dissolves Away (Dra) All Bondage And 'Stamps' The Universe Of Experience With The Seal (Mudra) Of The Fourth State (Turiya) Of Enlightened Consciousness Beyond, And Including, The Three States Of Waking, Dreaming And Deep Sleep. It Is Called 'Krama' Because It Is The Root Source Of All Emanation And All Other Conscious Processes Which Succeed One Another In Ordered Sequence (Krama) And Is, At The Same Time, Their Successive (Krama) Appearance As Well. By The Practice Of Kramamudra The Opposites Fuse And Siva And Sakti Unite. They Yogi Comes To Experience The Simultaneous Pervasion Of All The Lower, Grosser Categories Of Existence By The Higher And The Presence Of The Lower In The Higher. Commencing His Practice In A Low Form Of Bhairavimudra, The Yogi Conjoins The Outer With The Inner; Then, In Kramamudra, He Fills Both The Outer With The Inner And The Inner With The Outer. When He Achieves Perfection In This Two-Fold Movement, He Attains To The Highest Form Of Bhairavimudra In Which The Two Merge Completely In The Experience Of The Absolute (Anuttara), Free Of All Differentiation And Polarities. If He Fails To Maintain Awareness Of This State, He Again Falls Into Kramamudra Until He Has Finally Completely Merged All The Highest States In The Lower And The Lower In The Higher. He Then No Longer Needs To Resort To Any Means (Anupaya) To Achieve Liberation. All He Says Or Does Anything He Perceives Or Thinks, Instantly Occasions In Him The Highest Level Of Consciousness. Thus The Fruit Of Bhairavimudra Is The Wonder (Camatkara) Or Amazement (Vismaya) That Overcomes The Yogi When He Reaches The Plane Of Union (Yogabhumika) Y Xsl Where All Opposites Merge In The Radiance Of The Great Light Of Consciousness. The Stanzas On Vibration Teach: How Can One Who, As If Astonished, Beholds His Own Nature As That Which Sustains [The Existence Of Everything] Be Subject To This Painful Round Of Transmigration (Kusrti)? The Yogi, Recognising His True Nature To Be The Supreme Subject, Is Astonished To Suddenly Discover That The Individual He Thought He Was, Caught Up In The Trammels Of Thought And Living In A World Enmeshed In The Web Of Time And Space, Does Not Really Exist At All. He Experiences A 'Turning About' (Paravrtti) In The Deepest Seat Of The Doctrine Of Vibration Consciousness As He Penetrates His True Nature. The Sudden Eruption Of This Intuition (Pratibha) Arouses In Him A Cry Of Amazement As He Transcends All Thought-Constructs And, Perfectly Absorbed In His Own Nature, Is Liberated. The Path To Liberation Essentially, Spanda Doctrine Is Concerned With Two Matters. The First Is To Impart To Those Who Are Fit To Receive The Teachings A Deeper Understanding Of The Ultimate Goal Of Life (Upeya). When We Have Understood What Truly Benefits Us And Is Worth Attaining And What, On The Contrary, Is Of No Real Value But Stands In The Way Of This Attainment, We Can Begin To Make Progress Towards Our Goal. This Is Spanda Doctrine's Second Concern, Namely, To Show The Way In Which We Can Develop Spiritually Through Siva's Grace And The Right Application Of The Means To Realisation That It Teaches. When Both These Aspects Of The Teaching Have Been Correctly Understood And Applied, The Spanda Yogi Achieves A Clear And Permanent Realisation Of His Goal And Is Liberated, Thus Fulfilling The Ultimate Aim Of The Teaching. The Doctrine Of Vibration Is Not Meant For The Spiritually Dull. It Is Not For The Worldly Whose Consciousness, Clouded By Ignorance, Is As If Dreaming, Even During The Waking State Of Daily Life, The Dream Of Its Own Thought-Constructs. The Teachings Are Meant For Those Who Are Awake (Prabuddha), Those Who, Full Of Faith And Reverence, Are Always Alert And Intent On Discerning The True Nature Of Ultimate Reality. This Reality Is Understood In Three Basic Ways. The First Is Purely Transcendental. The Stanzas Choose This Aspect As The One Which Formally Defines It Most Specifically. Ultimate Reality Transcends All The Opposites, Including Subject And Object. This Does Not Mean, However, That It Is An Unconscious Void, A Mere Absence Of All Existence. In Fact, This Negative Characterization Of Reality (Which Includes Also A Denial Of All That Is Unconscious) Implies A Positive Immanence In Which The Opposites Are United In The Oneness Of Pure Consciousness That Is Equally Siva And Spanda, His Universal Activity. These Two Seemingly Contrasting Aspects Are Reconciled In The Third, Namely, Reality Understood As The Essential Nature Of All Things. Although Universal And Everywhere The Same, It Is Understood To Be The Essential And Specific Nature Of Each Existent As Its 'Own Nature' (Svabhava). In The Case Of The Individual Soul It Is Even More Specific, More Personal As His Own 'Own Nature' (Svasvabhava). Note Here That Svabhava Is Not Svasbhava. In Fact We Made A Statement That Svabhava Is The Very Characterstics Of Space Time Like, Crime Zones, Silent Zones, School Zones We Classify Space In To. Belonging To None Other Than Oneself It Is The Pure Subjectivity That Perceives Experiences, Enjoys, Reflects, Thinks And Senses As Well As Being The Conscious Agent Who Creates Every Possible Form Of Experience In All The States Of Consciousness. The Liberating Knowledge Of Reality Thus Corresponds To Our Regaining Possession Of Ourselves (Svatmagraha). We Must Lay Hold Of Ourselves And Abide In Our Authentic Nature. Reality Coincides With Our Own Most Fundamental State Of Being (Svasthiti), Free Of All Contrasts And Contradictions. Once We Have Overcome The Negative Forces That Arise From Our Ignorance And Prevent Us From Abiding In Ourselves, We Are Liberated. To Do This, We Must Penetrate Through The Pulsing Fluctuations Of Objectively Experienced States And Perceptions At The Surface Level Of Consciousness And Gain Insight Into The Timeless Rhythm Of Our Own Nature Manifest In The Universal Arising And Falling Away Of All Things. We Are Not Freed Of The Trammels Of Perpetual Change By Setting It Aside; On The Contrary, We Must Gain Insight Into The Recurrent Cycles Of Creation, Persistence And Destruction, Or Else Be Bound By Our Ignorance. This Spiritual Ignorance Consists Essentially Of Our Contracted State Of Consciousness And So Can Only Be

Effectively Countered By Expanding It To Reveal Our Own Authentic Nature As This Expanded State Itself, Which Is The Universal Vibration (Samanyaspanda) Of Consciousness. Vibration Of Strings Which Gives Shape To Objects Is Itself A Information, A Sine Qua Non Of Individual Consciousness. The Spanda- Yogi Treads The Path Of Consciousness Expansion. The Movement From The Contracted To The Expanded State Marks The Transition From Ignorance To Understanding, From The Dispersion And Incompleteness Of A Form Of Consciousness Entirely Centred On An Objectively Perceived And Discursively Represented Reality To A Direct, Intuitive Awareness Of The Unity And Integral Wholeness Of Our Own Absolute Spanda Nature. Along The Way To This Supreme Realisation Consciousness Develops, As Veil After Veil Is Lifted, Until It Becomes Full And Perfect In The Absolute Which Encompasses Within Itself All Possible Formats Of Experience. As Abhinava Says: [This Realisation] Is The Supreme Limit Of Plenitude And As Such There Can Be No Higher Attainment. Any [Other] Attainment [We Can] Conceive Issues From A State That Falls Short Of [This] Perfection. Once* [This] Uncreated Fullness Has Been Attained, Pray Tell, What Other Fruit Can There Be [Beyond It]? The Fettered Soul's Contracted State Of Consciousness Binds Him Because He Is Deprived Thereby Of The Subtle, Intuitive Insight Into The Underlying Unity Of Existence And His Attention Is Focused Instead On Its Gross, Outer Diversity Easily Apparent To Everybody, However Restricted His Consciousness May Be. However, Although The Fettered Soul In This State Is Ignorant Of This Unity, This Does Not Mean That His Knowledge Of Diversity Is False. Ignorance Entails A Form Of Knowledge Which, Although Quite Correct, Is Binding. We Are Not Absolutely Ignorant Of Reality For If We Were We Would Be Totally Unconscious. Spiritual Ignorance Is Always Linked With Some Degree Of Consciousness. Those Subject To The Round Of Birth And Death Are Not Inert Clods Of Earth. This Also Leads To Conclusion That Shakti Responsible Is Impure Because Of Maya Imbibed In It. Thus, Although Ignorance Obscures Consciousness, It Is Wrong To Think Of It, As Dualist Saivites Do, In Terms Of A Defiling Impurity That Shrouds It Like A Cloth Covering Ajar. Spiritual Ignorance Can Be Nothing But Consciousness Itself, Albeit In A Limited State. Siva, Who Is Universal Consciousness, Is The Innate Nature Of Both Its Contracted And Expanded States, Both Of Which Are Forms Of Knowledge, Namely: 1) Supreme Knowledge (Parajnana) Defined As The Revelation Of One's Own Innate Nature As The One Reality Which Is The Being Of All Things. 2) Inferior Knowledge (Aparajndna) Which Jayaratha Explains Results From The Mental Activity (Yyapard) Of The Individual Subject Whose Consciousness Is Contracted. It Consists Of The Mental Representations (Vikalpa) He Forms Of Himself And His Object, Of The Type I Know This'. The Lower Knowledge Obscures The Higher And Binds The Soul By Breaking Up His Direct, Pervasive Awareness Of His Own Pure Consciousness Nature, Free Of Mental Representation. The Stanzas On Vibration Teach: Operating In The Field Of The Subtle Elements, The Arising Of Mental Representation Marks The Disappearance Of The Flavour Of The Supreme Nectar Of Immortality; Due To This [Man] Forfeits His Freedom. As We Have Already Seen, Three Factors Are Necessary For Perception And Thought To Be Possible, Namely, The Perceiving Subject, The Means Of Knowledge And The Object Perceived. Rajanaka Rama, In His Commentary On The Stanza Cited Above, Explains At Length That These Three Factors Correspond To Three Major Divisions In The Lower Thirty-One Categories Of Existence, Namely: 1) The Object. This Consists Essentially Of The Five Primary Sensations Which Are The Subtle Elements {Tanmatras) Of Smell, Taste, Sight, Touch And Sound Along With The Five Gross Elements — Earth, Water, Fire, Air And Ether — Of Which These Sensations Are The Perceivable Qualities. 2) The Means Of Knowledge. This Consists Of The Senses And The Inner Mental Organ. 3) The Subject. At This Level, The Subject Is The Individual Soul (Purusa) Whose Consciousness Is Contracted By The Five Obscuring Coverings (Kancukas) Of Limited Knowledge And Action, Attachment, Natural Law And Time Along With Maya, Their Source. All These Categories Belong To The Impure Creation (Asuddhasrsti), Which Is The Sphere Of Maya Where The Lower Order Of Knowledge Operates And Subject And Object Are Divided. Above Them Are Five More Categories Which Belong To The Pure Creation (Suddhasrsfi) Where Subject And Object Are Still United. The Highest Of Those Categories Are Siva And Sakti. Combined They Represent The State Of Pure T Consciousness And Its Sentient Subjectivity (Upalabdhrta), Respectively. The Next Category Is Called Sadasiva. Here Faint Traces Of Objectivity Appear In The Pervasive, Undivided Consciousness Of Siva And Sakti. Consciousness, Now Full Of The Power Of Knowledge (Jnanasakti), Views The All In A State Of Withdrawal (Nimesa), Shining Within, And At One With Its Own Nature. T

Consciousness Predominates Over 'This' Consciousness Which It Encompasses In The Awareness That: 'I Am This [Universe]' (Aham-Idam). Next Comes The Category 'Isvara' Corresponding To The Awareness: 'This (Universe) Is Me' (Idam-Aham). 'This' Consciousness Takes The Upperhand Over T Consciousness And Unfolds Externally Full Of The Creative Power Of Action (Kriya&Akti). The All Now Becomes More Clearly Manifest As An Independent Reality. It Is Still Experienced As One With Consciousness But Is No Longer Fully Merged Within It. Finally, When Both Subjective And Objective Aspects Share An Equal Status In The Two-Fold Awareness That: 'I Am This (Universe) And This (Universe) Is Me (Ahamidam-Idamaham)\ Pure Knowledge (Fuddhavidya), The Last Of These Categories, Emerges. The Pure Categories Are The Experience Of The Impure Categories When They Are Recognised To Be One With Consciousness. They Are Experienced Within The Domain Of The Pure Universal Subject The Enlightened Yogi Realises Himself To Be. Mental Representations (Yikalpa) Emerge From This Pure Awareness And Subside Into It In Consonance With The Rhythm Of The Emanation And Withdrawal Of The Lower Categories. Impelled By The Universal Will, This Movement Is Spontaneous And Free. Free Of All Hopes And Fears The Enlightened Yogi Sees All Things As Part Of This Eternal Cosmic Game, Played In Harmony With The Blissful Rhythm Of His Own Sportive Nature At One With All Things. The Stanzas On Vibration Teach: Everything Arises [Out Of) The Individual Soul And He Is All Things. Being Aware Of Them, He Perceives His Identity [With Them]. Therefore There Is No State In The Thoughts Of Words Or [Their] Meanings That Is Not Siva. It Is The Enjoyer Alone Who Always And Everywhere Abides As The Object Of Enjoyment. Or, Constantly Attentive, And Perceiving The Entire Universe As Play, He Who Has This Awareness (Sawvitti) Is Undoubtedly Liberated In This Very Life. According To The Doctrine Of Vibration, Only Liberation In This Life (Jivanmukti) Is Authentic Liberation. Liberation After Death (Yideha- Mukti) In Some Form Of Disembodied State Free Of All Perceptions And Notions Of The World Of Diversity Is Not The Ultimate Goal. Ksemaraja Stresses That Liberation Is Only Possible By Realising One's Own Identity With The Whole Universe, However Difficult This May Be. Similarly, He Maintains That The Suspension Of All Mental And Sensory Activity, Which Takes Place In The Introverted Absorption Of Contemplation With The Eyes Closed (Nimilanasamadhi) That Leads To Identification With Transcendent Consciousness Is Complemented And Fulfilled By The Cosmic Vision Had Through The Expansion Of Consciousness That Takes Place In Contemplative Absorption With The Eyes Open (Unmilanasamadhi). Consequently, Ksemaraja Explains That The First Of The Three Sections, Into Which He Divides The Stanzas, Deals With The Former Mode Of Contemplation And The Second Section With The Latter. Significantly, The Last Stanza Of The Second Section Ends With The Declaration That 'This Is The Initiation That Bestows Siva's True Nature'. In Other Words, This Realisation, Attained Through The Expanding Consciousness Of Contemplation With The Eyes Open, Initiates The Yogi Into The Liberated State, Which Is Identification With Siva Whose Body Is The Universe. In Order To Attain This Expanded State Of Liberated Consciousness, The Yogi Must Find A Spiritual Guide Because The Master (Guru) Is The Means To Realisation. The Master Is For His Disciple Siva Himself For It Is He Who Through His Initiation, Teaching And Grace, Reveals The Secret Power Of Spiritual Discipline. Instructing In The Purport Of Scripture He Does More Than Simply Explain Its Meaning: He Transmits The Realisation It Can Bestow. The Master Is At One With Siva's Divine Power Through Which He Enlightens His Disciple. It Is This Power That Matters And Makes The Master A True Spiritual Guide, Just As It Was This Same Power That Led The Disciple To Him In His Quest For The Path That Leads To The Tranquility That Can Only Be Found 'In The Abode Beyond Mind'. The Master Is The Ferry That Transports The Disciple Over The Ocean Of Thought — If, That Is, The Disciple Is Ready. The Disciple Must Be 'Awake' (Prabuddha) 2% Attending Carefully To The Pulse Of Consciousness. This Alert State Of Wakefulness Is At Once The Keen Sensitivity Of Insight As Well As The Receptivity Of One Who Has No Other Goal To Pursue Except Enlightenment. The Highest, Most Perfect Relationship The Disciple Can Have With His Master Is Such As It Is With Siva Himself: One Of Identity. The Exchange That Takes Place Between Them Is An Internal Dialogue Within Universal Consciousness, Their Common Identity (Svabhava). Limiting Itself To A Point Source (Anu) And Obscured By The Thought-Constructs Born Of Doubt And Ignorance, Consciousness Assumes The Guise Of The Disciple Who Seeks To Attain The Expanded Fullness Of His Master's Consciousness. The Master, On The Other Hand, Embodies The Aspect Of Consciousness Which Responds To The Inquiring Consciousness Of His Disciple. Free Of The Notions Of 'Self

And 'Other', When The Disciple Is Liberated By His Grace, It Is The Master Who In Reality Liberates Himself. Although Ksemaraja Assures Us That The Master Can By Himself Enlighten His Disciple By The Initiation He Imparts To Him And The Other Means (Yukti) N He Adopts, Even So, He Is Not The Only Guide On The Path. Apart From The Master There Is Scripture And, Above All, One's Own Personal Experience, Because, As Abhinava Says: The Knowledge [Acquired] By Gradually [Coming To Understand The Meaning Of] The Scriptures And Following The Master [Who Knows Them] Leads, [When] Confirmed For Oneself, To The Realisation Of One's Own Identity With Bhairava. It Is Important To Know The Scriptures. God Reveals Himself Through Them; They Are One Of The Forms In Which He Is Directly Apparent In This World. They Teach Man What Is Worth Attaining And What Should Be Avoided And So Like A Boat Convey Him Across The Ocean Of Profane Existence (Samsara) To The Other Shore Where God's True Nature Is Revealed To Him. However, The Study Of The Scriptures Is Of Value Only If Accompanied By The Spiritual Knowledge That Results From Personal Experience. Mahesvarananda Writes: Being Well Versed In The Nature Of Deity Is One Thing, But Being Well Versed In The Sacred Scripture Is Another, Just As The Peace Of That Abode Is One Thing And What Worldly People Experience Is Another. Vasugupta, Who Found The Sivasutra, Knew The Means To Realisation (Yukti) As Well As The Scriptures And Had Fully Experienced The One Ultimate Reality. Therefore, Ksemaraja Declares Him To Be Amongst The Best Of Teachers. The Stanzas On Vibration (That Ksemaraja Attributes To Vasugupta) Accordingly Transmit The Secrets Of The Sivasutra In Accord With Scripture, Sound Reasoning And Personal Experience. The Latter Is Particularly Important For The Spanda Yogi; He Is Not Interested In Wasting His Time In Useless Discussion About The Experience Of Consciousness Expansion And Its Fruits, For That Can Only Be Known For Oneself. The Yogi Can Achieve This Experience Either Through Faith In The Master Or Personal Insight (Svapratyayatah) Acquired By Unswerving Devotion To God. Ksemaraja Accordingly Quotes A Passage From The Bhagavadgita Where Krsna Says: Those I Deem To Be The Best Yogis Who Fix Their Thoughts On Me And Serve Me, Ever Integrated [In Themselves], Filled With The Highest Faith. But While The Yogi's Development Depends On Faith And Personal Experience Of The Higher States Of Consciousness, He Can, And Must, Strengthen His Conviction In The Light Of Reason .When Reason (Upapatti) And Direct Insight (Upalabdhi) Work Together, They Serve As A Means To Liberation. Reason Alone Cannot Help Us, But When It Is Based On An Intuitive Insight Of Fundamental Principles Along With A Direct Experience Of Reality, Error Is Eradicated And The Yogi Is Freed. In This Way The Awakened Yogi Realizes His Inherent Spiritual Power (Svabala) With Which He Exerts Himself To Distinguish Between The **Motions Of Individualized Consciousness And The Universal Vibration (Samanyaspanda)** Of The Collective Consciousness That Is Their Ultimate Ground And Firm Foundation. Note The Information Of Individual, Collective And Cosmic General Ledger Is Alone Responsible For Creation And Also Destruction. Thus, Although The Doctrine Taught In The Stanzas On Vibration Accords With Scripture, It Is Supported By Reason And Above All By Personal Experience. Thus, For Example, The Seventeenth Stanza Describes The Difference In The Manner In Which The Well Awakened And The Unawakened Experience Their Own Nature (Atmopalambha While The Eighteenth Describes The Experience Of The Well Awakened In The Three States Of Waking, Dreaming And Deep Sleep. Indeed, Rajanaka Rama, One Of The Commentators, Explains That The First Sixteen Stanzas Establish On The Basis Of Personal Experience (Svanubhava) That One's Own True Nature Is Independent Of The Body. Similarly, The Remaining Stanzas Also Discuss The Direct Experience Of One's Own Nature, But This Time As The Unity Of All Things. This Direct Experience, In Its Diverse Aspects, Is Both The Means By Which The Yogi Develops His Consciousness As Well As His Ultimate Goal. **Doctrine Of Vibration: Mark S.G.Dyczkowski Models See Next Paper** From the point of view of the object, the expansion (unmesa) of this pulse is represented(eb) by the initial desire to perceive (didrksa) a particular object, while the contracted (nimesha) phase is (=) the withdrawal of attention from the object previously perceived. From the point of view of the perceiving subjectivity, the phases are (=) reversed, so that the initial desire to perceive marks (eb) the contraction (nimesha) of subjective consciousness while the falling away of the previous perception is (=) its expansion (unmesa). At the higher level, where these two phases are experienced within (eb) consciousness, they represent (eb) the state of the categories of Isvara ('this universe is me') and Sadasiva ('I am this universe'). Utpaladeva says: Expansion (unmesa\ which is in (eb) the external manifestation [of objectivity], is (=) Kvaratattva while contraction (Niemba), which is in the internal manifestation [of subjectivity], is Sadasiva. **There is no glorification or mortification here. It just like joining the job and retiring the involution and evolution phases**.(italics mine)The Doctrine of Vibration At this level all the powers of consciousness fuse (e&eb) and both phases are (=) manifest as part of one reality. This unity is in fact apparent (eb) to everybody at each moment. However, within the domain of Maya, which is the sphere of differentiated perceptions (Yikalpa), it is clearly manifest (eb) only at the juncture (Madhya) between two cognitions. In this Centre resides (eb) the void (kha) of consciousness (free of (e) thought-constructs) which divested of (e) diversity, digests into (eb) itself all the psycho-physical processes that give (eb) life to the multiplicity of perceptions. **Here it is important to note that the when the cosmic general ledger zero reflects upon itself and it is projected on the individual consciousness you see a film an illusory animations wherein creation itself becomes subjective wherein the individual consciousness is both the perceiver the perceived being the image on the screen on the screen of individual consciousness**. The yogi moves from the particular vibrations of consciousness at its periphery to (e&eb) the universal throb of the Heart in the Centre. As Abhinava explains: The self-reflective awareness in (eb) the Heart of pure consciousness, present (eb) at the beginning and end of each perception, within (eb) which the entire universe is (=) dissolved away without residue, is (=) called in the scriptures, the universal vibration of consciousness (samanyaspanda) and is (=) the outpouring (uccalana) [of awareness] within one's own nature. All the categories of existence (tattvas) are united in (eb) the Heart of the Centre where the life-giving elixir of Siva's consciousness floods (e&eb) one's own inner nature. To reside in the Centre is to abide by (e) the law of totality (gramadharma) in a state which transcends (e) the workings of the mind (unmana).Consciousness (jnana) with Light as its support, residing in (eb) the Centre between being and non-being is (=) known as the act of abiding in (eb) one's own abode as (=) the perceiving subjectivity (dratfrtva) free of (e) all obscuration. That which has been purified by (e) pure awareness **(suddhavijnana)** is called the transcendent (viviktavastu), said to be (=) the mode of being (v/7//) of the law of totality (gramadharma) through (e&eb) which everything is (=) easily attainable. The power in the Centre (madhyasakti) is (=) the eternal Present Beyond time it is the source of both past and future. To be established there is to abide without a break in Rama, the supreme enjoyer, in every action of one's life. Rama is Siva, the supreme cause Who pervades the fourteen aspects which embrace the entire universe of experience, namely, moving, standing, dreaming, waking, the opening and closing of the eyes, running, jumping, exertion, knowledge [born] of the power of the senses, the [three] aspects of the mind, living beings, names and all kinds of actions. This came as a natural development in Spanda doctrine not only for **this reason but also because the universal ego is experienced as the inner dynamics of absolute consciousness. To conclude our summarial exposition of the Divine Means, which is centred on the direct experience of this pure ego (and hence on Spanda in this form), we turn now to a brief description of its inner, cyclic activity. We shall do this** by examining Abhinava's esoteric exegesis of the symbolic significance of the word 'A HAM', which in Sanskrit means T, and symbolises by its form the ego's dynamic nature. “Dasein Does Not Fill Up A Track Or Stretch ‘Of Life’ — One Which Is Somehow Present-At-Hand — With The Phases Of Its Momentary Actualities. It Stretches Itself Along In Such A Way That Its Own Being Is Constituted In Advance As A Stretching-Along. The ‘Between’ Which Relates To Birth And Death Already Lies In The Being Of Dasein … It Is By No Means The Case That Dasein ‘Is’ Actual In A Point Of Time, And That, Apart From This, It Is ‘Surrounded’ By The Non-Actuality Of Its Birth And Death. Understood Existentially, Birth Is Not … Something Past In The Sense Of Something No Longer Present-At-Hand; And Death Is Just As Far From Having The Kind Of Being Of Something … Not Yet Present-At-Hand But Coming Along … Factical Dasein Exists As Born; And, As Born, It Is Already Dying, In The Sense Of Being-Towards-Death. As Long As Dasein Factically Exists, Both The ‘Ends’ And Their ‘Between’ *Are*, And They Are In The Only Way Possible On The Basis Of Dasein’s Being As *Care* … As Care, Dasein Is The ‘Between’.” **— Martin Heidegger (Thomas Piel - Traducteur), Being And Time** Path to Liberation On without knowledge that everything is manifest within consciousness is illusory or unreal in that sense alone. 78 Things are more real or more tangibly experienced according to their own essential nature (svabhava) to the degree in which we recognise that they are appearances (abhasa) within absolute consciousness As Jayaratha says: Just as images manifest in a mirror, for example, are essentially mere appearances, so too are [phenomena] manifest within conscious- ness. Thus, beause they are external, [phenomena] have no being (sattva) of their own. The Lord says this [not with the intention of saying anything about the nature of things] but in order to raise the level of consciousness of those people who are attached to outer things; thus everything in this sense is essentially a mere appearance. [Knowing this], in order to quell the delusion of duality, one should not be attached to anything external. 79 The ultimate experience is the realisation that everything is contained within consciousness. We can discover this in two ways. Either we merge the external world into the inner subject, or we look upon the outer as a gross form of the inner. In these two ways we come to recognise that all things reside within our own consciousness just as consciousness resides within them. This all-embracing inwardness is only possible if there is an essential identity between the universe and consciousness. The events which constitute the universe are always internal events happening within consciousness because their essential nature is consciousness itself. 80 We can only account for the fact that things appear if there is an essential identity between consciousness and the object perceived. If a physical object were really totally material, that is, part of a reality independent of, and external to, consciousness, it could never be experienced. Abhinava says: The existence or non-existence of phenomena within the domain of the empirical (iha) cannot be established unless they rest within consciousness. In fact, phenomena which rest within consciousness are apparent (prakasamana). And the fact of their appearing is itself their oneness {abheda) with consciousness because consciousness is nothing but the fact of appearing {prakasa). If one were to say that they were separate from the light of [that consciousness] and that they appeared [it would be tantamount to saying that] 'blue' is separate from its own nature. However, [insofar as it appears and is known as such] one says: 'this is blue 1 . Thus, in this sense, [phenomena] rest in conscious- ness; they are not separate from consciousness. The Doctrine of Vibration The universe and consciousness are two aspects of the whole, just as quality and substance constitute two aspects of a single entity. The universe is an attribute (dharma) of consciousness which bears (dharmiri) it as its substance. It is said that 'substance' is that resting in which this entire group of categories manifests and is made effective. Now, if you don't get angry [we insist that] this entire class of worlds, entities, elements and categories (tattva) rests in consciousness and [resting in it] is as it is. Thus consciousness contains everything in the sense that it is the ground or basis (adhard) of all things, their very being (satta) and substance from which they are made. But, unlike the Brahman of the Advaita Vedanta, it is not the real basis (adhisthand) of an unreal projection or illusion. Consciousness and its contents are essentially identical and equally real. They are two forms of the same reality. Consciousness is both the substratum and what it supports: The perceiving awareness and its object. In this respect, the Kashmiri Saiva is frankly and without reserve an idealist. Although he does not deny the reality of the object, his position is at odds with most commonly accepted forms of realism. The realist maintains that the content perceived is independent of the act of perception. The content is only accidentally an object of perception and undergoes no change in the process of being perceived. His contention, however, is essentially unverifiable; to verify it, we would have to know an object without perceiving it. This, from the Kashmiri Saiva point of view, is not possible. Objects of which we have no knowledge may indeed exist, but they are knowable as objects only if they are related to subjects who perceive them. In this sense, if there were no subjects, there could be no objects. 86 The subject, however, as opposed to the object is, in terms of the phenomenology of perception, apparent to himself. He is self-luminous (svaprakdsa). Thus, conscious- ness (the essence of subjectivity) is one s own awareness by virtue of which all things exist. The realist maintains that consciousness clearly differs from its object insofar as their properties are contrary to each other. The Saivite idealist. However, says that the object is a form of awareness (vijnanakara)™ The objective status of the object is cognition itself. Perception manifests its object and renders it immediately apparent (sphuta) to those who perceive it. It does not appear at any other time. If 'blue' were to exist apart from the cognition of k blue\ two things would appear: 'blue' and its cognition, which is not the case. It is the perception of the object which constitutes its manifest nature. An entity becomes an Integral Monism of Kashmiri Saivism object of knowledge not by virtue of the entity itself but by our knowledge of it. If objects had the property of making other objects appear, it would be possible for one object to make another appear in its own likeness. 'Blue' is perceived to be 'blue' because it is manifest as such to the perceiver. As Abhinava points out: The [nature of an] object of knowledge could not be established through a means of knowledge totally unrelated to it — a crow does not become white because a swan [sitting next to it] is white. Perception, on the other hand, is immediately apparent to conscious- ness. It is self-luminous in the sense that it is directly known without need of being known by any ulterior acts of perception and makes its object known at the same time. Adopting the Buddhist Yogacara doctrine that things necessarily perceived together are the same (sahopa- lambhaniyamavada), the Saivite affirms that because the perceived is never found apart from perception, they are in fact identical. Reality (satya) is the point where the intelligible and the sensible meet in the common unity of being; it cannot be said to exist in itself outside, and apart from, knowledge or vision. Bhagavatotpala in his commentary on the Stanzas on Vibration quotes: Once the object is reduced to its authentic nature, one knows [the true nature of] consciousness. What then [remains of] objectivity? What [indeed could be] higher than consciousness? Consciousness is essentially active. Full of the vibration of its own energy engaged in the act of perception, it manifests itself externally as its own object. When the act of perception is over, consciousness reabsorbs the object and turns in on itself to resume its undifferentiated inner nature. Knowledge (jnana) manifests internally and externally as each individual entity.... Once knowledge has assumed that form it falls back [into itself]. The Yogacara Buddhist similarly maintains that consciousness creates its own forms. But, according to him, because the perceived and perception are identical; there is no perceived object at all. The so-called outer world is merely a flux of cognitions, it is not real. He is firmly committed to a doctrine of illusion. The reality of consciousness from The Doctrine of Vibration his point of view is established by proving the unreality of the universe. "All this consists of the act of consciousness alone", says Vasubandhu, "because unreal entities appear, just as a man with defective vision sees unreal hair or a moon, etc."He points to dreams as examples of purely subjective constructs which appear to be objective realities. The apparent reality dreams possess is not derived from any concrete, objective world, but merely from the idea of objectivity. While the Yogacara does not say that an idea has, for example, spatial attributes, it does have a form manifesting them. While he agrees with the Saiva idealist that appearances have no independent existence apart from their appearing to consciousness, he maintains that for this reason they are unreal. The creativity of consciousness consists in its diversification in many modes having apparent externality; it is not a creation of objects. While the Kashmiri Saivite agrees that the world is pure conscious- ness alone, he maintains that it is such because it is a real creation of consciousness. The effect is essentially identical with the cause and shares in its reality. Matter and the entire universe are absolutely real, as 'congealed' (sty ana) or 'contracted' (samkucita) forms of consciousness. "This God of consciousness", writes Ksemaraja, "generates the universe and its form is a condensation of His own essence (rasa)" m By boiling sugarcane juice it condenses to form treacle, brown sugar and candy which retains its sweetness. Similarly, consciousness abides unchanged even though it assumes the concrete material form of the five gross elements. The same reality thus abides equally in gross and subtle forms. Consequently no object is totally insentient. Even stones bear a trace (vasana) of consciousness, although it is not clearly apparent because it is not associated with the vital breath (prana) and other components of a psycho-physical organism. Somananda goes so far as to affirm that physical objects, far from being insentient, can only exist insofar as they are aware of themselves as existing. The jar performs its function because it knows itself to be its agent. Indeed, all things are pervaded by consciousness and at one with it and hence share in its omniscience. Thus, Siva, Who perceives Himself in the form of physical objects, is the one ultimate reality. "The jar knows because it is of my nature", writes Somananda, "and I know it because I am of the jar's nature. I know because I am of Sadasiva's nature and He knows because He is of my nature; Yajnadatta [knows] because he is of Siva's nature and Siva [knows] because He is of Yajnadatta's nature". Integral Monism of Kashmiri Saivism Everything in this sense is directly perceived by absolute conscious- ness, and this direct perception (pratyaksa) unifies the knowable into a single, undivided whole. This is the central concept behind a doctrine originally expounded by Narasimha called 'the non-dualism of direct perception' (pratyaksadvaita). This states that consciousness is essentially perceptive and that its perception of all things operates throughout the universe. Insofar as phenomena are clearly evident (sphufa) to us, everything is directly perceived by absolute consciousness, with which our individual consciousness is identical. This direct perception unfolds everywhere; the one true reality, it is alone and without companion or rival (nihsapatna). Even though it remains one, it can, by its very nature, perceive distinctions (bheda) between one entity and another, without this engendering any division within it. We distinguish between two entities in empirical terms on the basis of their mutual exclusion (anyonyabhava). The relative distinction {bheda) between them is essentially the perceived difference between their respective characteristics.

Despite this difference they are united within the purview of a single cognition insofar as they are equally both manifest appearances. This cognition is the undivided essence (rasa) or 'own nature' (svabhava) of both. Encompassed by the 'fire of consciousness', there is no essential difference between them. Just as when an emerald and ruby reflect each other's light, the ruby is reddish-green and the emerald greenish-red, similarly everything is connected with everything else as part of the single variegated (vicitra) cognition of absolute consciousness. Mahesvarananda writes: The Supreme Lord's unique state of emotivity (asadharanabhava) is the outpouring of pure Being (mahasatta). It is manifest as the brilliance (sphuratta) of the universe which, if we ponder deeply, [is realized to be] the single flavour (ekarasa) of the essence of Beauty which is the vibration of the bliss of one's own nature. In this way all things are in reality one although divided from the one another sharing as they do the 'single flavour' (ekarasa) of the pure vibration of consciousness. Kashmiri Saiva Realism Kashmiri Saivism as a whole has been variously called a form of 'realistic idealism', 'monistic idealism', ‘idealistic monism' and 'concrete monism'. It is easy to understand why Kashmiri Saivism is The Doctrine of Vibration said to be 'idealistic' and 'monistic', but in what sense is it also 'realistic*? The answer to this question is of no small importance in trying to under- stand the central idea behind its metaphysics and the fundamental importance of the concept of Spanda, in this seemingly impossible marriage between monistic idealism and pluralistic realism. The Kashmiri Saiva approach understands the world to be a symbol of the absolute, that is, as the manner in which it presents itself to us. Again we can contrast this view with that of the Advaita Vedanta. The Advaita Vedanta understands the world to be an expression of the absolute insofar as it exists by virtue of the absolute's Being. Being is understood to be the real unity which underlies empirically manifest separateness and as such is never empirically manifest. It is only transcendentally actual as 'being-in-itself. The Kashmiri Saiva position represents, in a sense, a reversal of this point of view. The nature of the absolute, and also that of Being, is onceived as an eternal becoming (satatodita), a dynamic flux or Spanda, 'the agency of the act of being'. It is dentified with the concrete actuality of the fact of appearing, not passive unmanifest Being. Appearance (abhasa) alone is real.ppearing (prakasamanatva) is equivalent to the fact of being (astitva). Ksemaraja writes in his commentary on the Stanzas on Vibration: Indeed, all things are manifest because they are nothing but manifestation. The point being that nothing is manifest apart from manifestation The absolutely unmanifest, from this point of view, can have as little existence as the space in a lattice window of a sky-palace. Nay, even less, because even that space can appear as an imagined mage manifest within consciousness. Everything is real according to the manner in which it appears. Even an illusion is in this sense real, insofar as it appears and is known in the manner in which it appears. The empirical and the real are identical categories of thought. As Abhinava says: Thus this is the supreme doctrine (upanisatf), namely that, when- ever and in whatever form [an entity] appears, that then is its particular nature. Perhaps at this stage a brief comparison with Heidegger's ideas might prove to be enlightening and not altogether out of place. According to Heidegger's phenomenology of Being, reality is intelligible in a two-fold Integral Monism of Kashmiri Saivism manner as 'phenomenon' and 'logos'. Heidegger defines what he means by 'phenomenon' as: "that-which-shows-itself. The manifest . . . phenomena are then the collection of that which lies open in broad daylight or can be brought to the light of day — what the Greeks at times implicitly identified as 'ta onta' (the things-which-are)". 127 In his later writings Heidegger drops the term 'phenomenon' in preference for the verbal form 'phainesthai' in order to emphasize even more the actuality or presentational property of Being. Explaining this new form of the term he writes: "Being disclosed itself to the ancient Greeks as 'physis'. The etymological roots 'phy-' and 'pha-' designate the same thing: 'phyein', the rising-up or upsurge which resides within itself as 'phainesthai', lighting-up, self-showing, coming-out, appearing-forth." Heidegger contrasted his notion of phenomenon with semblance (Schein) and with appearing (Erscheinung). In the case of semblance a thing can show itself as that which it is not, as when fool's gold shows itself to be gold. The ancients always allied semblance with non-being. Heidegger points out, however, that semblances are grounded in showings, and so does Abhinava. Both Heidegger and Abhinava consequently maintain that all semblances have a real basis and are to be treated as instances of phenomena along with the so-called real showing or manifestation of non-deceptive objects. So Heidegger states that: 'how- ever much seeming, just that much being'. Thus self-showing or appearing defines Being as phenomenon, but this definition of Being is as yet incomplete. Being is not only self-showing but 'logos' which Heidegger explains means 'discourse' (Rede) in the sense of 'apophansis': 'letting-be-seen'.

Phenomenology, which according to Heidegger is the only correct study of Being, means 'letting-be-seen-that-which- shows-itself. This is true of Saiva Paramadvaita as well. The reality of the world demands recognition; we are forced to accept the direct presentation of the fact of our daily experience. As Abhinava says: "if practical life, which is useful to all persons at all times, places and conditions were not real, then there would be nothing left which could be said to be real." A thousand proofs could not make 'blue' other than the colour blue. The reality of whatever appears in consciousness cannot be denied. Objects appear; they do not cease to do so by a mere emphatic denial. The manifestation of an entity in its own specific form is a fact at one level of consciousness; it is real. The appearing of the same entity in the same form but recognised to be a direct representation of the absolute is also a fact, but at another level of consciousness. It is no more or less real than the first. 'As is the state of consciousness, so is the experience,' says Abhinava. Although the nature of the absolute is discovered at a higher level of consciousness, The Doctrine of Vibration nonetheless it presents itself to us directly in the specific form in which we perceive things; otherwise there would be no way in which we could penetrate from the level of appearing to that of its source and basis. Abhinava writes: Real is the entity iyastu) that appears in the moment of direct perception (sak$atkara), that is to say, within our experience of it. Once its own specific form has been clearly determined one should, with effort, induce it to penetrate into its pure conscious nature. All things are known to be just as they present themselves. The concrete actuality of being known (pramiti), irrespective of content, is itself the vibrant (spanda) actuality of the absolute. Liberating knowledge is gained not by going beyond appearances but by attending closely to them. "The secret," Mahesvarananda says, "is that liberation while alive (jivanmukti) is the profound contemplation of Maya's nature." No ontological distinction can be drawn between the absolute and its manifestations because both are an appearing (dbhasa), the latter of diversity and the former of 'the true light of consciousness which is beyond Maya and is the category Siva'. Those who have attained the category of Pure Knowledge above Maya and have thus gone beyond the category of Maya, see the entire universe as the light of consciousness . . . Just as the markings [on a feather] are nothing apart from the feather, the feather [is nothing apart from] them, similarly, when the light of consciousness is manifest, the whole group of phenomena is manifest as the light of consciousness itself. Within the sphere of Maya, every entity's 'own nature' (svabhdva) corresponds to its specific manifest form. Accordingly it is defined as that which distinguishes it from all else and from which it never deviates. Above the sphere of Maya, that is, above the level of objectivity, is the domain of the subject. At this level, everything is realised to be part of the fullness of the experience r and hence no longer bound by the conditions which impinge on the object. Here the part is discovered to be the whole, that is, consciousness in toto. In this sphere beyond relative distinctions, the yogi realises that (all) the categories of existence are present in every single category. m The yogi experiences every individual particular as the sum total of everything else. He recognises that all things have one nature and that every particular is all things. This is the 'essence' (sard) or co-extensive unity (samarasya) of all things. Integral Monism of Kashmiri SaivismWe have established that reality is manifest according to how [and the degree in which] the freedom of consciousness reveals it and that [this freedom] is the womb of all forms. Just as 'sweetness' is present in its entirety in every atom of the sugarcane, so each and every atom [of the universe] bears within itself the emanation of all things. This is the level of consciousness in which the absolute reflects on itself realising to its eternal delight and astonishment (camatkara) its own integral nature. The reality of the world of diversity is not denied, but experienced in a new mode of awareness free of time and space in the eternal omnipresence of the Here and Now. [Phenomenal forms of awareness] such as 'this [exists]', born of the colouring [imparted to the absolute] by the limitations engendered by the diversifying power of time {kalakalana) also emanate within the Supreme Principle. There [at that level], Fullness {purriata) is the one nature [of all things] and so everything is omnipresent; otherwise, associated with division (khancjlana), the Fullness [of the absolute] would not be full. The content of absolute consciousness consists of diverse appearings (abhdsa) which, because they are manifest through it in this way, do not compromise the wholeness of consciousness. Everything we perceive is a momentary collocation of a number of such manifestations which combine together like 4 a row of altar lamps' (dipavalT) to form the single radiant picture of the universe. The individual objects which constitute the universe are specific collocations of such 'atomic' appearings. Together they form a single unified particular which appears according to its own defining features (svalaksand). A jar, for example, consists of a number of appearances such as 'round', 4 fat\ 'earthen', 'red', etc., which together discharge a single function (arthakriya), in this case, that of carrying the appearance 'water'. They unite with each other much as the scattered rays of a lamp come together when focused, or as the various currents of the sea together give rise to waves. Atomic appearings can combine in any number of ways, provided that they are not contrary to one another as established by the dictates of natural law (niyati). An appearance of 'form', for example, cannot combine with that of 'air'. Insofar as they share a common basis (samanyadhikaranya), a given cluster of appearances appears as a single whole. This common basis is the most prominent member of the group; the appearance 'jar' is such in the example quoted above. Any one appearance in a cluster may assume a more important or subordinate role. The result is a specific The Doctrine of Vibration awareness of an object of the form: 'here this is such.' While individual appearances do not lose their separate identity {svarupabheda) when they rest on a common basis, even so the particular object which appears according to its own characteristics (svalak$ana) is an individual reality in its own right. It is a different kind of appearance characterised by its association with the appearance of the specific location and time in which it is made manifest. The form of our experience is thus 'I now see this here'. But when we perceive each particular constituent appearance separately, each assumes a separate fixed function. Abhinava cites the following colourful example to illustrate how the various combinations of appearances account for the variety of experience: Thus even though the appearance of the beloved may manifest externally, it is as if far away in the absence of another appearance, namely, that of 'embracing'. So when the [appearing of the beloved] is associated with another appearance [namely that of 'far away'] the power (arthakriya) it formerly had of giving pleasure appears as its contrary. The form our experience assumes depends, not only on the nature of the object perceived, but also on personal factors entirely peculiar to ourselves. This theory explains this in two ways. In one sense, the object remains the same, but one or other of its constituent appearances comes to the fore according to the inclinations of the perceiver. From another point of view, we can say that the perceived object is different for each perceiver according to the difference in the prominent appearance manifest to him. Abhinava, citing as an example a golden jar, illustrates how the same object appears differently to different perceivers according to the use they wish to make of it and to their state of mind: When a person who is depressed and feels that there is nothing [of value for him in the world] sees the jar, he merely perceives the appearance 'exists' [in the form of the awareness that] 'it is\ He is not conscious of any other [of its constituent appearances] at all. An individual who desires to fetch water [perceives] the appearance 'jar'. The man who simply wants something that can be taken somewhere and then brought back [perceives] the appearance 'thing'. The man who desires money [perceives] the appearance 'gold'. The man who desires a pleasing object [perceives] the appearance 'brightness' while he who wants something solid sees the appearance 'hardness'. These 'atomic events' or appearances emerge from the pure subject's consciousness and combine together to form a total event at each moment. Integral Monism of Kashmiri Saivism Daily life (vyavahara) goes on by virtue of this ever renewed flux of appearances. They are connected together and work towards a single unified experience because they appear within the field of consciousness of the universal subject. The aggregate of appearances arises in the [supreme] subject as do [sprouts in] a rice field. Even though each sprout germinates from its own seed, they are perceived as a collective whole. Appearances rest in this way within the universal subject. 'External- ity' is itself another appearance; it arises from a distinction between appearances and the individual subject. So, although all manifestation always occurs within the subject, it appears to be external due to the power of Maya which separates the individual subject from his object. This split must occur for daily life to be possible. Only externally manifest appearances can perform their functions; when they are merged within the subject and at one with him, they cannot do so. Daily life proceeds on the basis of the operation and withdrawal of the conditions necessary for fruitful action to be possible. Appearance in this sense represents the actualisation of a potential hidden in consciousness made possible by virtue of its dynamic, Spanda nature which is both the flow from inner to outer and back as well as the power that impels it. The emergence from, and submergence into, pure consciousness of each individual appearance is a particular pulsation (visesaspanda) of differentiated awareness. Together these individual pulsations constitute the universal pulse (samanyaspandd) of cosmic creation and destruction. Thus, every single thing in this way forms a part of the radiant vibration {sphuratta, sphurana) of the light of absolute consciousness. Light and Awareness: The Two Aspects of Consciousness Absolute consciousness understood as the unchanging ontological ground of all appearing is termed

'Prakasa'. As the creative awareness of its own Being, the absolute is called ' Vimarsa '. Prakasa and Vimarsa — the Divine Light of consciousness and the reflective awareness this Light has of its own nature — together constitute the all-embracing fullness (purnata) of consciousness. The Recognition (pratyabhijfia) school of Kashmiri Saivism develops this concept of the absolute which finds its fullest expression in Utpaladeva's Stanzas on the Recognition of God. Even though neither of these two key terms appear in the Stanzas on Vibration or the Aphorisms of Siva, they recur frequently in their commentaries. Thus, although the original formulation of the Doctrine of Vibration differs from the theology of Recognition in this respect, it was extended in the course of its development to accommodate this concept of the absolute as well. This was possible, and quite justified, insofar as the absolute understood in Pratyabhijfia terms does not, as we shall see, differ essentially from that of the Spanda school. We can, as Kashmiri Saivites themselves have done, explain one in terms of the other. The Doctrine of Vibration Prakasa: The Light of Consciousness Prakasa is the pure luminosity' (bhdna) or 'self-showing' that constitutes the essence and ultimate identity (atman) of phenomena. That things appear at all is due to the light of consciousness, and their appearing (avabhasana) is itself this Light which bestows on all things their evident, manifest nature. Established in the light of consciousness everything appears there according to its own specific nature (svabhava). Anything that supposedly does not rest in this Light is as unreal as a sky-flower. 3 Thus, according to Rajanaka Rama, unlike the light of the sun, or any other light, this Light not only makes all things apparent, it is also their ultimate source. 4 Full of its divine vibration the Light makes all things manifest and withdraws them into itself. This supra- temporal activity characterises it most specifically; devoid of it, it would be no better than an inert physical phenomenon. At the same time, this light is the conjunction (slesa) or oneness (aikdtmya) of its countless manifest forms, 6 and the collective whole (sampina'ana) of all the categories of existence. The universe is nothing but the shining of the Light within itself. It is the radiant vibration (sphuratta) of this Light, the state (avast hand) in which consciousness becomes manifest.Although the Light shines as all things at all times and hence also makes their diversity manifest, 9 penetrating each object individually as well as collectively, it is not totally 'merged' (magna) or identified with the object so as to suffer any division within itself. Our experience of any object is of the form: T see this': it is not itself an object, but the manifest form the object assumes as a luminous principle of experience. The Light is ever revealed and can never be obscured; objectivity can never cast a shadow on the light of consciousness. The Stanzas on Vibration declare: That in which all this creation is established and from whence it arises is nowhere obstructed because it is unconditioned by [its very] nature. This Light is the highest reality (paramartha). It is the 'Ancient Light' (puranaprakasa) that makes all things new and fresh every moment. It is 'always new and secret, ancient and known to all'. It is the form of the Present (vartamanarupa), the Eternal Now. Time and space are relations between the contents of consciousness; they cannot impinge on the integrity of the absolute itself. 16 Neither space nor time can divide it, for they are one with the Light that illumines them Light and Awareness: Two Aspects of Consciousness and makes them known as elements of experience. But this Light is the shining of the absolute; it is not an impersonal principle. It is the living Light of God, indeed it is God Himself, the Master Who instructs the entire universe. 18 Siva is this 'auspicious lamp', Who illumines all things. He is the Light of consciousness that reveals the presence of both the real and the unreal, of light' and 'darkness'. 20 Abhinavagupta writes: Thus Bhairava, the Light, is self-evident (svatahsiddha); without beginning, He is the first and last of all things, the Eternal Present. And so what else can be said of Him? The unfolding of the categories of existence (tattva) and creation, which are the expansion of His own Self, He illumines, luminous with His own Light, in identity with Himself, and because He illumines Himself, so too He reflects on His own nature, without His wonder (camatkara) being in any way diminished. Since Zwicky's early observations, similar data from other galaxy clusters has yielded the same result – we consistently see that clusters of galaxies appear to By developing an awareness of the Centre, the yogi experiences the bliss of consciousness. 117 Through this gap he plunges into introverted absorption (nimilanasamadhi) and then emerges again to pervade the field of awareness between Centres and so experience the Cosmic Bliss (jagadananda) of the universal vibration of consciousness. 1 i8 He then recognises that this state pervades every aspect of experience. In this way the yogi's consciousness is no longer afflicted by the power which obscures it, hemming the Centre in on both sides with thought-constructs that seemingly deprive it of its fullness. As he realises directly his pure conscious nature as the universal ego free of all mental representations, it expands out to embrace all things within itself. Thus the realisation the Divine Means leads to, and is directly based upon, is that this pure ego is in all things just as all things are within it. In the Spanda tradition, as recorded in the Stanzas on Vibration, no such ego is recognised. ' I9 Man's authentic nature is, however, understood in personal terms as every individual's own 'own nature* (svasvabhava) which is Siva, the universal vibration of pure subjectivity (upalabdhfta). It is not surprising, therefore, that later commentators found these two conceptions to be essentially the same and accordingly identified one's own inner nature with the pure ego. This came as a natural development in Spanda doctrine not only for **this reason but also because the universal ego is experienced as the inner dynamics of absolute consciousness. To conclude our summarial exposition of the Divine Means, which is centred on the direct experience of this pure ego (and hence on Spanda in this form), we turn now to a brief description of its inner, cyclic activity. We shall do this** by examining Abhinava's esoteric exegesis of the symbolic significance of the word 'A HAM', which in Sanskrit means T, and symbolises by its form the ego's dynamic nature. The objective world of perceptions is, as we have seen, essentially a chain of thought-constructs (prapanca) closely linked to one another and woven into the fabric of diversity (vicitrata). This thought (vikalpa) is a form of speech (vac) uttered internally by the mind (citta), which is itself an outpouring of consciousness. Consciousness also, in its turn, resounds with the silent, supreme form of speech {para vac) which is the reflective awareness through which it expresses itself to itself. Consequently, the fifty letters of the Sanskrit alphabet, which are the smallest phonemic units into which speech can be analysed, are symbolic of the principal elements of the activity of consciousness. Letters come together to generate words and words go on to form sentences. In the same way the fifty phases in the cycle of consciousness represent, in the realms of denoted meaning (vacya)the sum total of its universal activity (kriya) corresponding to the principal forces (kala) which come together to form the metaphysical categories of 186 The Doctrine of Vibration experience, which in their turn appear in the grossest, most explicitly 'articulate' form as the one hundred and eighteen world-systems (bhuvana). 'A', the first letter of both AHAM and the Sanskrit alphabet, is the point of departure or initial emergence of all the other letters and hence denotes Anuttara — the absolute. 'Ha', is the final letter of the alphabet and represents the point of completion when ail the letters have emerged. It represents the state in which all the elements of experience, in the domains of both inner consciousness and outer unconsciousness, are fully displayed. It is also the generative, emission (visarga) which, like the breath, casts the inner into the outer, and draws what is outside inward. The two letters 'A' and 'Ha' thus represent Siva, the transcendental source and Sakti, His cosmic outpouring that flows back into Him. The combined 'A-Ha' contains within itself all the letters of the alphabet — every phase of consciousness, both transcendental and universal. (For a graphic representation of this analysis, see figure 1.) M, the final letter of AHAM, is written as a dot placed above the letter which precedes it. It comes at the end of the vowel series and before the consonants and so is called 'anus vara '(lit. 'that which follows the vowels') and also 'bindu ' (lit. 'dot,' 'drop,' 'point' or 'zero'). While the consonant 'M' symbolises the individual soul (purusa), 'bindu 1 rep resents the subtle vibration of T, which is the life force (jivakala) and essence of the soul's subjectivity manifest at the transcendental, supra-mental level (unmana). 12 ° It is the zero-point in the centre between the series of negative numbers, in this case the vowels which represent the processes happening internally within Siva, and the series of positive numbers — the consonants which symbolise the processes happening externally within Sakti. Bindu, as a point without area, symbolises the non-finite nature of the pure awareness (pramitibhava) of AHAM. It is the pivot around which the cycle of energies from 'A' to 'Ha' rotates, the Void in the centre from which all the powers emanate and into which they collapse. As such, it is the supreme power of action which holds subject, object and means of knowledge together in a potential state in the one Light that shines as all three 121 containing them in its repose 122 (visrdnti). Bindu is the 'knower' (jndtr), who is essentially consciousness that, though omniscient does not manifest its intelligence, like a man who knows the scriptures but having no occasion to explain them to others silently bears this knowledge within himself. As such, it symbolises the union of Siva and Sakti (sivasakti- mithunapina'a) 123 in a state of heightened potency in which they have not yet divided to generate the world of diversity. It stands, in other words, at the threshold of differentiation in the stream of emanation still contained within Siva. Expansion Commences Bindu — The Individual Soul Withdrawal Commences Figure 1 188 The Doctrine of Vibration Then, to the degree in which that which is to be accomplished by the power of action residing within it [as a potential] penetrates into the absolute, it appears initially as bindu, which is the light of pure consciousness. 124 When outer objectivity is reabsorbed into its transcendent source, bindu is the point into which all the manifest powers of consciousness are gathered and fused together. The universal potency of all the letters is thus contained in bindu which, as the reflective awareness of supreme T consciousness, 125 gives them all life. Thus bindu also marks the beginning of Siva's internal movement back to the undifferentiated absolute and so stands at the threshold of both emission and absorption without being involved in either. The three aspects of AH AM together constitute a movement from the undifferentiated source of transcendental consciousness — 'A' — through the expansion or emission of its power — 4 Ha' — to the subject — 'M 1 — which contains and makes manifest the entire universe of experience. The reverse of this movement, which of withdrawal (samhara), is represented by M-Ha-A. AHAM and M-Ha-A alternate in the rotation (ghurnana) of the reflective awareness of T consciousness as immanent Sakti emerges from transcendental Siva to then merge back into Him. As Abhinava says: The universe rests within Sakti and She on the plane of the absolute (anutiara) and this again within Sakti ... for the universe shines within consciousness and [consciousness shines] there [within the universe by the power of] consciousness. These three poles, forming a couple and merging, make up the one supreme nature of Bhairava Whose essence is AHAM- 126 At the microcosmic level, fc A' represents the initial moment when the subject begins to rise out of himself to view the object. The movement from 'A to 'Ha' marks the emergence of sensation within the field of awareness, which is represented by the fifty letters of the alphabet symbolic of the fifty aspects of the flux of consciousness leading to objectified perception. 'Nl' is tne subject who, resting content within himself when he has perceived his object, merges through the inner flow of awareness into k A\ the absolute. Then from the absolute (A) its emission (Ha) flows back into the pure subject (M) set to perceive his object. Thus all the cycles of creation and destruction are contained within AHAM through which they are experienced simultaneously as the spontaneous play of the absolute. The yogi who recognises this recurrent pulse of awareness to be the movement of his own consciousness merges his limited ego with the Path to Liberation universal ego. **This is natures general ledger** Thus he realises that its power to create, sustain and destroy all things is his own inner strength (svabaia) that he exerts effortlessly in the same state of mystical absorption (turlya) in universal consciousness that the absolute itself enjoys. In this way he shares in the three-fold awareness Siva Himself has of His own nature which Abhinava describes as follows: 4 I make the universe manifest within myself in the Sky of Consciousness. I, who am the universe, am its creator! ' — this awareness is the way in which one becomes Bhairava. 'AH of manifest creation (sadadhvari) is reflected within me, I cause it to persist 1 — this awareness is the way in which one becomes the universe. The universe dissolves within me. I who am the flame of the [one] great and eternal fire of consciousness' — seeing thus one achieves peace. 127 The experience of the liberated thus coincides with the realisation of their own divine nature which, through its power, rules and guides the cosmic order. Thus this attainment (siddhi), which is liberation itself, is in the DoctrLie of Vibration technically called 'Mastery over the Wheel of Energies' (cakresvaratvasiddhi) because the liberated soul, identified with Siva, now governs, as does Siva, the cycle of the powers that bring about the creation and destruction of all things, Here we are talking of individual consciousness becoming cosmic general ledger and the liberationist realises all destruction and creation is by him. This clearly means that he is in his own world of illusion. Creation is subjective quintessentially The Empowered Means (Saktopaya) All the practices taught in the Stanzas on Vibration are internal. Whenever ritual is mentioned, it is invariably interpreted in terms of the dynamics of the inner processes the yogi experiences and implements in the course of his yogic practice. The Doctrine of Vibration, Ksemaraja affirms, 129 is concerned entirely with these inner disciplines centred, as it is, in one way or another, on consciousness or, at least, on the inner activity of the mind. Thus the Empowered Means which, like the other categories we have discussed, is entirely internal, includes an important part of Spanda practice. Spanda practice belonging to the Divine Means centres on one's own inherent nature (svasvabhava) as Siva, the universal perceiver and agent, that belonging to the Empowered Means on His power. Instead of arriving directly at the all-embracing emptiness of subjective conscious- ness, the yogi practising the Empowered Means realises his true nature through the fullness of its energy. Practising the Divine Means, the yogi plunges, as it were, straight into the fire of consciousness; practising the 190 The Doctrine of Vibration Empowered Means he merges with its rays. Either way the yogi is centred equally on ultimate reality. The power of consciousness is no less absolute than its possessor. To make this point Abhinava quotes the Matanga- tantra: This reality consists of the rays of [Siva's] power and is variously said to be the abode of the Lord's manifestation . . . That same [power] illumined [by Siva] is itself also luminous, unshaken and unmoving. That very [power] is the supreme state, subtle, omnipresent, the nectar of immortality, free of obscuration, peaceful, yearning for pure Being alone {vastumatra) and devoid of beginning and end. Perfectly pure, it is said to be the body [of ultimate reality]. 110 The yogi concentrates on the powers operating in all of life's activities as particular pulsations (visesaspanda) in the universal rhythm (samanyaspanda) of the power of consciousness. In this way he rises progressively from the particular to the universal until he reaches pure Being (satta), the greatest of all universals (mahasamanyd) and the highest form of Siva's power. Thus the creative power of Maya, manifest through countless lesser powers, no longer causes the yogi to stray from Siva's consciousness but becomes the means through which it can be realised 13 1 in the illuminating brilliance (sphuratta) which is Siva's pure Being. Thus by discovering the true nature of Sakti, the yogi realises himself to be Siva, its possessor Who consists of all its countless powers. Thus practise belonging to this Means leads to the same pure consciousness free of thought-constructs realised through the Divine Means. Although the ultimate realisation is instantaneous, the yogi rises to it gradually by freeing his consciousness of the limitations imposed upon it by thought. Abhinava explains: The same occurs in the Empowered Means [as does in the Divine]. At the discursive level of consciousness {yaikalpikibhumi) [where the Empowered Means functions] knowledge and action, although evident, are, for the reasons explained previously, contracted. A blazing energy [is revealed within] the one who dedicates himself to removing the burden of this contraction. [This energy eventually] brings about the inner manifestation {antarabhasa) of pure consciousness he seeks. 132 Consciousness is individualized and its power of knowledge and action contracted by the thought-constructs born of ignorance. The arising of these mental representations, as the Stanzas on Vibration say, deprives the soul of its freedom and immortal life. 133 The practise of the Path to Liberation 191 Empowered Means is meant to free the fettered soul of this constriction on his consciousness. It operates within the mental sphere (cetasy™ and is designed to purify thought (vikalpasamskara) in order to. reveal the pure consciousness which is its ground and ultimate source. Thus, the Empowered Means is concerned with the second instant of perception, during which the subject forms mental representations of his object. Thought functions on the basis of an awareness of relative distinctions between specific particulars, distinguishing them from one another and thus seemingly fragmenting the essential unity of reality. 135 The vibrant vitality of consciousness, universally manifest, is clouded like a mirror by a child's breath 136 and the soul is deprived of the liberating intuition of the one reality free of thought-constructs (nirvikalpa). Abhinava writes: The [fettered soul] is like a dancing girl who although wishing to leave the dancehall is collared by the doorkeeper of thought and thrown back onto the stage of Maya. 137 All thought is centred on objectivity and hence dislodges awareness from the plenitude of pure subjective consciousness. Thus, to regain the original state of rest (visranti) consciousness enjoys, the yogi must rid himself of thought. As thought-forms decrease, pure, thought-free awareness is strengthened 138 until the yogi is fully established in a state in which the relative distinctions (bheda) conceived between entities dissolve away. Everything appears to him as pure Being (sattdmdtra) l}9 and the entire universe shines before him pervaded by Siva's radiance. 140 His intuitive faculty (mati) thus purified, the yogi gains both the perfections (siddhi) of yogic practice and liberation (mukti). His consciousness is now like a well-polished mirror which reflects everything he desires and grants it to him. 141 Abhinava writes: Just as a man who has been ill for a long time forgets his past pain completely when he regains his health, absorbed as he is in the ease of his present condition, so too those who are grounded in pure awareness free of thought-constructs are no longer conscious of their previous [fettered] state. Consciousness, the sole truly existent reality, free of thought- constructs is made fully and evidently manifest by eliminating thesedifferentiated perceptions. The wise man should therefore exert himself to attend closely to this [state of awareness]. I42 The thought-constructs generated within consciousness do not in reality affect it at all. They can neither break up nor add anything to the Light which shines as all things. 143 They are in fact nothing but 192 The Doctrine of Vibration consciousness itself 144 which perceives, through its power of reflective awareness (yimarsa), the multitude of objects in diverse ways, and so assumes this form. 145 Although thought-constructs are mental representations of objects once seen or present, they are products of the power of consciousness and not of the objects they represent. 146 Thought is both analytic and synthetic; 147 it serves the useful purpose of separating individual elements of experience from others and linking together those that appear to be distinct from one another so that they can be better understood. 148 It does not consist merely of false mental constructs projected onto reality that need to be wholly rejected. Thought obscures consciousness and distracts it only when it appears in the form of doubt, vacillating between alternatives. 149 Once this conflicting duality (dvaitddhivasa) 150 is eliminated, thought is purified and rests in itself as the 'thought-less thought' of pure consciousness. 151 By gradually eliminating the multitude of conflicting notions that agitate him, the yogi ultimately achieves the certainty (niscaya) corresponding to a direct awareness of his own divine nature. 152 Abhinava explains: Thought is in reality none other than pure consciousness. Even so, it serves as a means to liberation for the individual soul (anu) only when it takes the form of certainty (niscaya). 153 The yogi must eliminate every doubt and misguided notion that leads him to believe himself to be other than Siva. By developing the thought: 4 1 am Siva', it ultimately affirms itself directly as a pure awareness beyond thought without any intervening mental representations. Abhinava says: Just as the man who thinks intensely that he is a sinner becomes such, just so one who thinks himself to be Siva, and none other than He, becomes Siva. This certainty (ddrtfhya), which penetrates and affirms itself in our thoughts, coincides with an awareness free of thought- constructs engendered by a series of differentiated mental representa- tions, the object of which is our identity with Siva. 154 As thought is gradually purified, it becomes progressively clearer until its object becomes maximally apparent (sphufatama). 155 The stream of perceptive consciousness (pramana) progressively reveals each aspect of its object which, thus affirming itself with increasing clarity, reveals its ultimate nature. The yogi reflects repeatedly upon it as the object of his realisation and loving devotion, for all that is perceptible and need be known (j fie yd) is Siva alone. As Abhinava says: Path to Liberation 193 What should we say of those who before they are satisfied have to see their beloved again and again, caress her and think about her for a long time? 156 The yogi practising the Empowered Means is initiated into the Great Sacrificial Rite (mahayaga), eternally enacted at the interface between the inner and outer aspects of consciousness, by a direct infusion of awareness from his master who is the embodiment and outer symbol of the yogi's enlightened identity. ,57 The rite begins with ritual bathing (snana) which is in this case the immersion of the body of thought in the white ashes of the cosmic fuel of duality, burnt in the fire of consciousness. 158 The yogi then goes on to worship (puja) by uniting all that is pleasing to the senses in the oneness of consciousness. 159 The ritual formula (mantra) he recites is the eternal resonance of the awareness which is the pulsation of the Heart of his own consciousness. 160 Repetition (Japa) of the formula is every activity, perception, breath or thought which arises within him while plunged in the universal awareness of his true nature. 161 The mental image he visualises meditating (dhyana) on the Deity in the course of the rite, is whatever the yogi spontaneously imagines and contemplates as the outpouring of the universal creativity of consciousness. 162 Ritual gesture (mudra) is whatever bodily posture the yogi may assume when, fully absorbed in consciousness, he moves, staggering about (ghumita) as it were, drunk with the wine of self-realisation. 163 Oblation is performed by offering with devotion and awareness all the sensations which flow in through the channels of the senses to the fire of his subjectivity, which is thus inflamed (uddipita) and makes all things one with itself. 164 The outer ritual which commences in the sphere of the Individual Means thus leads naturally to the inner rite of the Empowered Means. When the yogi's practise (abhyasa) reaches fruition, the rite merges with the spontaneous activity of consciousness. This is fullness (purnata), the completion and reunification of the forces within consciousness which, through the power of ignorance, were formerly dispersed and divided. "Just as a horse driven here and there", writes Abhinava, "over plains, hills and dales follows the will of its rider, so also consciousness, driven by various expedients (bharigi), quiescent or terrific, abandoning duality, becomes Bhairava. Just as by looking repeatedly at one's own face in a mirror one comes to know that it is the same [as the image reflected], so also, [one sees] in the mirror of mental representations of meditation {dhyana), ritual (puja) and worship (area) one's own Self as Bhairava and so quickly identifies with Him. This identification is the realisation that takes place in the absolute (anuttara)." 165 194 The Doctrine of Vibration By ridding himself of the relative distinctions engendered by thought, the yogi practising the Empowered Means, illumined by the power of self- awareness of Pure Knowledge {suddhavidya), transcends the distinction between right and wrong, purity and impurity. He is led to the conviction that the pure consciousness, which is his true nature, is unaffected by whatever action he may do, whether conventionally accepted as good or bad. Abhinava quotes the Malinivijaya as saying: All here is enjoined and all prohibited. This alone, O Lord of the gods, is here prescribed as obligatory, namely that the mind be firmly applied to the true reality. It matters little how this is achieved. He whose mind is firmly established in [this] reality, even if he eats poison, is as little affected by it as are lotus petals by water. 166 Impurity is a state of seeming separation from consciousness. 167 The yogi who has freed himself of all false notions comes to realise that the true nature of consciousness can never be sullied or limited by any object appearing within it. 168 This is the realisation the ancient sages achieved through a direct intuition of reality free of intruding thought-constructs {avikalpabhava), but kept secret in order not to confuse the worldly. 169 Similarly, in reality nobody is ever bound. It is ignorance to believe bondage exists and to contrast it with a conceived state of liberation. 170 If the Self is one with Siva, how can it be either bound or released? 171 Nothing essentially distinguishes those who are bound from those who are free. 172 The difference between their states is merely conceptual. 173 Pure consciousness abides free of all such distinctions. Thus Bhagavatotpala, <n his commentary on the Stanzas, repeatedly stresses that thought- constructs obscure consciousness and misguide the individual soul. 174 Those who are bound are convinced that they are dull witted, conditioned by Karma, sullied by their sin and helplessly impelled to action by some power beyond their control. He who manages to counter this conviction with its opposite achieves freedom. 175 He who considers himself to be free is free indeed, while he who thinks himself bound remains so. Thus at the highest level of realisation, as Abhinava says: Nothing new is achieved nor is that which in reality is unmanifest, revealed- [only] the idea is eradicated that the luminous being shines not. 176 Nothing is impure, all is perfect, including Maya and the diversity it engenders. To say that illusion exists and that ignorance must be Path to Liberation 195 eradicated implies that it has a separate existence apart from conscious- ness. If this is so, it has as little reality as the shadow of a shadow, but if not,then it must be consciousness itself. Thus, as Kallata says, bondage, the binder and the bound are in fact one. 177 It is Siva Himself Who freely obscures His own nature. Siva binds Himself by Himself. 178 Concealing and revealing Himself, Siva plays His timeless game. At the Divine (sambhava) level of pure Siva-consciousness, the Spanda yogi directly lays hold of the power inherent in his own conscious nature (svabala) which gives life to the psycho-physical organism and impels the senses and mind to action. 179 In this way every thought- construct, and with it the ego, is instantly annulled in the immediacy of the pure subjectivity that remains unaltered throughout every perception and state of consciousness. The same takes place at the Empowered level b> attending to the recurrent activity — Spanda — of the subject, that is, the flux of awareness through the cyclic movement of the powers of consciousness. 180 By attending (avadhana) to this movement the thought- constructs that emerge and subside in the course of perception are seen to be part of this universal process, and, in this way purified, are no longer binding. Thus, Ksemaraja says that the Spanda teachings are concerned most directly with the Empowered Means. m The yogi who is always alert to discern the pulse of Spanda quickly realises his own authentic state of being (nijarfi bhavam). 1 * 2 He is then truly awake, not only literally, but also in the deeper sense that he is awake to his authentic nature, its power and activity. When attention (avadhana) slackens, this movement takes place unconsciously and so the thought-constructs and perceptions generated through it appear to take on an autonomous existence of their own, just as happens when we dream. 183 The spontaneity of the movement that travels between subject and object and holds them together in the pure awareness of the universal subject's identity with his cosmic object devolves into the creative activity of waking and dreaming. Man, in other words, becomes a victim of his states of consciousness and the contents that they, by their very nature, generate within themselves. 184 The Spanda teachings are not only concerned with the structure of thought and its functions, but also with the powers and properties of its vehicle, namely, speech. Speech issues out of consciousness, develops into thought to then become articulated sound. A focal point of Spanda doctrine is thus the role speech plays in the formation of thought- constructs and their purification. Although this takes place at all levels of practise below the Divine (sambhava), the Spanda teachings, meant as they are for advanced yogis, ignore the outer forms of spiritual discipline to concentrate on practise in the Empowered (sakta) psychic sphere (cetas) and what lies beyond it where speech is the pure inner awareness (yimarsa) **Although Abhinava does not differentiate between individual consciousness and cosmic general ledger, one tends to comprehend that right interpretation is the transfor mentioned the individual consciousness to cosmic consciousness responsible for the creation and destruction which the sadhaka sees as**

his own power. Every one is rama and every one is Shiva. only thing that is essential is striving and concerted efforts and sustained struggle to reach. The Doctrine of Vibration of the light of consciousness. The Doctrine of Vibration identifies this, the highest level of speech (para vac), with the universal pulse of consciousness that resounds spontaneously within it as the inner flow of its own undifferentiated awareness. 185 Beyond the realms of language, it is the transcendental consciousness in which all language is rooted and pervades all that language denotes as its essential being. Utpaladeva writes: The Supreme Voice is consciousness. It is self-awareness spontaneously arisen, the highest freedom and sovereignty of the Supreme Lord. That pulsing radiance (sphuratta) is pure Being, unqualified by time and space. As the essence [of all things] it is said to be the Heart of the Supreme Lord. 186 When the intention arises within consciousness to discern its own brilliance manifest in the world of denotations and denoted meanings, speech turns from the supreme transcendental level to that of immanence and assumes the form of a pure intuitive awareness (pratibha) which perceives and comprehends its universal manifestation. This is the voice of intuition (pasyanti), which grasps the meaning inherent inwardly in all words and externally in all that they denote. Analogous to the non- discursive, instinctual knowledge animals possess, it is a pure generic perception not yet formed into language in which the act of denotation, its object and that which denotes it are indistinguishable. Illumined by the voice of intuition birds migrate in their due seasons, the cock crows at dawn and young mammals suck at the breast. 187 Infants similarly reflect and respond instinctively to their environment by virtue of this intuitive sense 188 and through it come to grasp the link between words and the objects they denote. As they learn to speak, they begin to form concepts and so the next two levels of speech develop. One is the outer corporeal speech (yaikhari) and the other the subtler, inner discourse (antah- saryijalpa) of thought that forms at the intermediate level (madhyama) where the ratiocinating mind stands between the higher levels of intuition and its outer verbal expression. In this way the development of speech in infancy reflects its progressive actualisation in every spoken word. A hymn to the Goddess quoted by Bhagavatotpala describes this process well: Therefore, O Supreme Goddess, the highest form of speech should be worshipped as the [universal] cause that establishes the existence of all things by insight {niscaya) into their nature (artha) brought about by their manifestation through the superimposition [of verbal designations]. O Mother, insight into the true nature [of things] is nothing but the Path to Liberation 197 act of intent of that [same speech], apart from which [speech itself and all that it expresses] could not attain to its own nature. Again, in that state [speech] is said to be the light of one's own nature. Free of division and succession it is attainable [only] by the yogi. Then from the state of intent, O Siva, speech [assumes] the nature of thought as the radiant pulse (sphuraria) of desire to speak of that which is in the domain of words. Then consisting of words, it bears a clearly expressed meaning, for if [speech] were not such, meaning could not be understood. 189 personal experience clearly proves that thought is invariably associated with speech. 190 Thought is a function of language. Through it we communicate to ourselves a mental image of the world about us and can construct complex ideas about ourselves. Language is the fabric from which our world of ideas is woven. Mental representation which orders the influx of sensation and presents us with a meaningful, picture of the world, memory, the elaboration of ideas and the shifting tides of emotion are all intimately connected with language and through it to the consciousness which underlies them. To think of language as nothing more than a system of denotation based on a commonly accepted convention (sanketd) fails to fully account forks inherent power to convey meaning (vacakasakti). In order to learn the convention we must be born with an innate ability to grasp meaning, and this ability is not itself learned nor found anywhere within the domain of convention. Lacking this ability we would be caught in an infinitely expanding system of denotation in which each element pointed to some other within it, without ever coming to rest anywhere. Unless we can couple the word 'jar' with the object it denotes, explaining that the word 'pot' is a synonym of the word 'jar' would leave us none the wiser. 191 The connection between word and meaning is only explicable if we postulate that it is an inherent property of the power of awareness to link one with the other. Language must be grounded in the pure cognitive awareness (prama) of consciousness which stands beyond, and yet illumines, the sphere of experience we define and understand through the medium of language. As Abhinava says: Someone may hear another person speak, but if his awareness (prama) is obscured, he is unable to rise, unconscious as he is, to the level of the experiencing subject [who understands] what has been said. He only grasps the outer successive (sound) of what the other person says and thus can only repeat it as would a parrot. An understanding of its meaning presupposes that he has caught hold of his own power of awareness (prama) by attaining the autonomy [of the conscious, universal subject]. **Note that we have defined sachitananada as one which understand Truth and Untruth, Bliss and Unbliss, and Knowledge and ignorance where all these are equal. Truth=Untruth, Bliss=Unbliss and Ignorance=Knowledge** The Doctrine of Vibration Outer, articulate speech consists of a series of ordered phonemic elements produced and combined by the vocal organs to form meaningful words. In order for this to be possible, these elements must also be grounded in consciousness (prama). The articulated phonemes are merely outer, gross manifestations of the phonemic energies (yarnagrama) held in a potential state within consciousness. This 'mass of sounds* (sabdarasi) is the light of consciousness (prakdsd) which makes the universe manifest and contains all things within itself. In other words, it is the totality of consciousness expressed as the collective awareness symbolised by all the letters corresponding to the introverted subjectivity of Siva Himself. The power through which this potential actualises itself into speech and the world of denotation is technically called * Mdtrkd*. It is the reflective awareness (vimarsa) and radiance (sphuratta) of the supreme subject — the 'mass of sounds' (Jabdarasi) — and the undivided wonder Siva experiences when He contemplates the universe He gathers up into Himself in the form of countless words (vdcaka) and their meanings (vdcya). 193 Mdtfkdsakti is manifest in the second movement of consciousness after the primal vibration of the pure luminosity of the 'mass of sounds', as the state of pure potency which arises when its unsullied subjectivity begins to turn away from itself and is associated with faint traces of objectivity (dmrsya- cchdyd). 194 Mdtrkd contains within itself the various aspects of objectivity that, although not yet manifest, are ready to issue forth. Thus this power, at one with Siva, is called 'Mdtrkd' because she is the mother (mdtrkd) of the universe that she contains within herself as does a pregnant woman her child. 195 The circle of the powers of Mdtrkd (mdtrkdcakra) consists of the phonemic energies contained in AH AM, the universal ego. 196 When grasped in its entirety at its source, these energies elevate the consciousness of the enlightened, but when split up and dispersed give rise to the obscuring forces (kald) which lead the ignorant away from realisation. The fettered soul is ignorant of the pure egoity that is the source of speech and so it generates, through its powers, the many thought-constructs that deprive him of the awareness of unity and obscure Siva's universal activity. 197 The Stanzas on Vibration declare: He who is deprived of his power by the forces of obscuration {kala) and a victim of the powers arising from the mass of sounds (sabdardsi) is called the fettered soul. 198 The powers [of speech] are always ready to obscure his true nature as no mental representation can arise that is not penetrated by speech. 199 The rays of phonemic energies emanate from the light of Siva, the Path to Liberation 199 'mass of sounds' (sabdarasi) in eight groups. They constitute the powers of the inner mental organ and the five senses, figuratively arranged in a circle around the sacred shrine {pi(ha) of Matrka&akti who manifests externally as the body. 200 The eight classes and the names of the deities presiding over them are as follows: 201 Gutturals Brahman! Intellect (buddhi) Palatals Mahegvari Ego (ahankara) Cerebrals Kaumarl Mind (manas) Dentals Narayani Hearing Labials Varahi Touch Semivowels Aindri Sight Sibilants Camuntfa Taste Vowels Mahalak§ml Smell The yogi who grasps the true nature of the power of Matfka and its phonemic forces is liberated 202 by recognising that the activity of the senses and the discursive representations of the mind are in fact emanations of universal consciousness. Conversely, when ignorant, he is affected by its power in its multiple negative aspects known as 'Mahdghora' ('greatly terrible') and, unable to rest within himself free of the sense of diversity, he is constantly disturbed by the flux of extroverted perceptions. Abhinava explains: When the [phonemic energies] are not known to be [emanations of the Lord] they conceal the wonder (camatkara) of consciousness which is the one essential non-discursive awareness [present throughout perception] and even in discursive thought. They obscure it with thought-constructs constituted by the diverse configurations of phonemes and syllables which [although also] a form of the deity [are no longer benevolent but] most terrible. Inducing doubt and fear, they engender the fettered soul's state, bound by the shackles of transmigra tion. But once their true nature is understood correctly in this way, they bestow freedom in this very life This knowledge of their intimate being [at one with the absolute] consists of this, namely, that even in the midst of all these fluctuations, free at their inception of discursive representations, thought-constructs do not conjoin [individualised consciousness] with the wheel of energies consisting of the totality of phonemes, even though [these constructs] are coloured by the many diverse words generated by the aggregate of phonemes. Language has a powerful effect on us. A few words we may hear or read can inspire us with joy, fear or sadness, and the constant inner 200 The Doctrine of Vibration dialogue of thought arouses intense feelings within us. This power hidden in language, which binds us through the thought-constructs it generates, can also be used to free us of them by channeling it through Mantra. Mantric practice begins at the Individual (driava) level where Mantras are recited in consonance with the rising and falling away of the breath. In this way they are charged with the vibration (spandd) of consciousness and, in their turn, make consciousness vibration (Doctrine of Vibration S.G.Dyczkowski) On without knowledge that everything is manifest within consciousness is illusory or unreal in that sense alone. 78 Things are more real or more tangibly experienced according to their own essential nature (svabhava) to the degree in which we recognise that they are appearances (abhasa) within absolute consciousness As Jayaratha says: Just as images manifest in a mirror, for example, are essentially mere appearances, so too are [phenomena] manifest within conscious- ness. Thus, beause they are external, [phenomena] have no being (sattva) of their own. The Lord says this [not with the intention of saying anything about the nature of things] but in order to raise the level of consciousness of those people who are attached to outer things; thus everything in this sense is essentially a mere appearance. [Knowing this], in order to quell the delusion of duality, one should not be attached to anything external. 79 The ultimate experience is the realisation that everything is contained within consciousness. We can discover this in two ways. Either we merge the external world into the inner subject, or we look upon the outer as a gross form of the inner. In these two ways we come to recognise that all things reside within our own consciousness just as consciousness resides within them. This all-embracing inwardness is only possible if there is an essential identity between the universe and consciousness. The events which constitute the universe are always internal events happening within consciousness because their essential nature is consciousness itself. 80 We can only account for the fact that things appear if there is an essential identity between consciousness and the object perceived. If a physical object were really totally material, that is, part of a reality independent of, and external to, consciousness, it could never be experienced. Abhinava says: The existence or non-existence of phenomena within the domain of the empirical (iha) cannot be established unless they rest within consciousness. In fact, phenomena which rest within consciousness are apparent (prakasamana). And the fact of their appearing is itself their oneness {abheda) with consciousness because consciousness is nothing but the fact of appearing {prakasa). If one were to say that they were separate from the light of [that consciousness] and that they appeared [it would be tantamount to saying that] 'blue' is separate from its own nature. However, [insofar as it appears and is known as such] one says: 'this is blue 1 . Thus, in this sense, [phenomena] rest in conscious- ness; they are not separate from consciousness. The Doctrine of Vibration The universe and consciousness are two aspects of the whole, just as quality and substance constitute two aspects of a single entity. The universe is an attribute (dharma) of consciousness which bears (dharmiri) it as its substance. It is said that 'substance' is that resting in which this entire group of categories manifests and is made effective. Now, if you don't get angry [we insist that] this entire class of worlds, entities, elements and categories (tattva) rests in consciousness and [resting in it] is as it is. Thus consciousness contains everything in the sense that it is the ground or basis (adhard) of all things, their very being (satta) and substance from which they are made. But, unlike the Brahman of the Advaita Vedanta, it is not the real basis (adhisthand) of an unreal projection or illusion. Consciousness and its contents are essentially identical and equally real. They are two forms of the same reality. Consciousness is both the substratum and what it supports: The perceiving awareness and its object. In this respect, the Kashmiri Saiva is frankly and without reserve an idealist. Although he does not deny the reality of the object, his position is at odds with most commonly accepted forms of realism. The realist maintains that the content perceived is independent of the act of perception. The content is only accidentally an object of perception and undergoes no change in the process of being perceived. His contention, however, is essentially unverifiable; to verify it, we would have to know an object without perceiving it. This, from the Kashmiri Saiva point of view, is not possible. Objects of which we have no knowledge may indeed exist, but they are knowable as objects only if they are related to subjects who perceive them. In this sense, if there were no subjects, there could be no objects. 86 The subject, however, as opposed to the object is, in terms of the phenomenology of perception, apparent to himself. He is self-luminous (svaprakdsa). Thus, conscious- ness (the essence of subjectivity) is one s own awareness by virtue of which all things exist. The realist maintains that consciousness clearly differs from its object insofar as their properties are contrary to each other. The Saivite idealist. However, says that the object is a form of awareness (vijnanakara)™ The objective status of the object is cognition itself. Perception manifests its object and renders it immediately apparent (sphuta) to those who perceive it. It does not appear at any other time. If 'blue' were to exist apart from the cognition of k blue\ two things would appear: 'blue' and its cognition, which is not the case. It is the perception of the object which constitutes its manifest nature. An entity becomes an Integral Monism of Kashmiri Saivism object of knowledge not by virtue of the entity itself but by our knowledge of it. If objects had the property of making other objects appear, it would be possible for one object to make another appear in its own likeness. 'Blue' is perceived to be 'blue' because it is manifest as such to the perceiver. As Abhinava points out: The [nature of an] object of knowledge could not be established through a means of knowledge totally unrelated to it — a crow does not become white because a swan [sitting next to it] is white. Perception, on the other hand, is immediately apparent to conscious- ness. It is self-luminous in the sense that it is directly known without need of being known by any ulterior acts of perception and makes its object known at the same time. Adopting the Buddhist Yogacara doctrine that things necessarily perceived together are the same (sahopa- lambhaniyamavada), the Saivite affirms that because the perceived is never found apart from perception, they are in fact identical. Reality (satya) is the point where the intelligible and the sensible meet in the common unity of being; it cannot be said to exist in itself outside, and apart from, knowledge or vision. Bhagavatotpala in his commentary on the Stanzas on Vibration quotes: Once the object is reduced to its authentic nature, one knows [the true nature of] consciousness. What then [remains of] objectivity? What [indeed could be] higher than consciousness? Consciousness is essentially active. Full of the vibration of its own energy engaged in the act of perception, it manifests itself externally as its own object. When the act of perception is over, consciousness reabsorbs the object and turns in on itself to resume its undifferentiated inner nature. Knowledge (jnana) manifests internally and externally as each individual entity.... Once knowledge has assumed that form it falls back [into itself]. The Yogacara Buddhist similarly maintains that consciousness creates its own forms. But, according to him, because the perceived and perception are identical; there is no perceived object at all. The so-called outer world is merely a flux of cognitions, it is not real. He is firmly committed to a doctrine of illusion. The reality of consciousness from The Doctrine of Vibration his point of view is established by proving the unreality of the universe. "All this consists of the act of consciousness alone", says Vasubandhu, "because unreal entities appear, just as a man with defective vision sees unreal hair or a moon, etc."He points to dreams as examples of purely subjective constructs which appear to be objective realities. The apparent reality dreams possess is not derived from any concrete, objective world, but merely from the idea of objectivity. While the Yogacara does not say that an idea has, for example, spatial attributes, it does have a form manifesting them. While he agrees with the Saiva idealist that appearances have no independent existence apart from their appearing to consciousness, he maintains that for this reason they are unreal. The creativity of consciousness consists in its diversification in many modes having apparent externality; it is not a creation of objects. While the Kashmiri Saivite agrees that the world is pure conscious- ness alone, he maintains that it is such because it is a real creation of consciousness. The effect is essentially identical with the cause and shares in its reality. Matter and the entire universe are absolutely real, as 'congealed' (sty ana) or 'contracted' (samkucita) forms of consciousness. "This God of consciousness", writes Ksemaraja, "generates the universe and its form is a condensation of His own essence (rasa)" m By boiling sugarcane juice it condenses to form treacle, brown sugar and candy which retains its sweetness. Similarly, consciousness abides unchanged even though it assumes the concrete material form of the five gross elements. The same reality thus abides equally in gross and subtle forms. Consequently no object is totally insentient. Even stones bear a trace (vasana) of consciousness, although it is not clearly apparent because it is not associated with the vital breath (prana) and other components of a psycho-physical organism. Somananda goes so far as to affirm that physical objects, far from being insentient, can only exist insofar as they are aware of themselves as existing. The jar performs its function because it knows itself to be its agent. Indeed, all things are pervaded by consciousness and at one with it and hence share in its omniscience. Thus, Siva, Who perceives Himself in the form of physical objects, is the one ultimate reality. "The jar knows because it is of my nature", writes Somananda, "and I know it because I am of the jar's nature. I know because I am of Sadasiva's nature and He knows because He is of my nature; Yajnadatta [knows] because he is of Siva's nature and Siva [knows] because He is of Yajnadatta's nature". Integral Monism of Kashmiri Saivism

Everything in this sense is directly perceived by absolute conscious- ness, and this direct perception (pratyaksa) unifies the knowable into a single, undivided whole. This is the central concept behind a doctrine originally expounded by Narasimha called 'the non-dualism of direct perception' (pratyaksadvaita). This states that consciousness is essentially perceptive and that its perception of all things operates throughout the universe. Insofar as phenomena are clearly evident (sphufa) to us, everything is directly perceived by absolute consciousness, with which our individual consciousness is identical. This direct perception unfolds everywhere; the one true reality, it is alone and without companion or rival (nihsapatna). Even though it remains one, it can, by its very nature, perceive distinctions (bheda) between one entity and another, without this engendering any division within it. We distinguish between two entities in empirical terms on the basis of their mutual exclusion (anyonyabhava). The relative distinction {bheda) between them is essentially the perceived difference between their respective characteristics. Despite this difference they are united within the purview of a single cognition insofar as they are equally both manifest appearances. This cognition is the undivided essence (rasa) or 'own nature' (svabhava) of both. Encompassed by the 'fire of consciousness', there is no essential difference between them. Just as when an emerald and ruby reflect each other's light, the ruby is reddish-green and the emerald greenish-red, similarly everything is connected with everything else as part of the single variegated (vicitra) cognition of absolute consciousness. Mahesvarananda writes: The Supreme Lord's unique state of emotivity (asadharanabhava) is the outpouring of pure Being (mahasatta). It is manifest as the brilliance (sphuratta) of the universe which, if we ponder deeply, [is realized to be] the single flavour (ekarasa) of the essence of Beauty which is the vibration of the bliss of one's own nature. In this way all things are in reality one although divided from the one another sharing as they do the 'single flavour' (ekarasa) of the pure vibration of consciousness. Kashmiri Saiva Realism Kashmiri Saivism as a whole has been variously called a form of 'realistic idealism', 'monistic idealism', ‘idealistic monism' and 'concrete monism'. It is easy to understand why Kashmiri Saivism is The Doctrine of Vibration said to be 'idealistic' and 'monistic', but in what sense is it also 'realistic*? The answer to this question is of no small importance in trying to under- stand the central idea behind its metaphysics and the fundamental importance of the concept of Spanda, in this seemingly impossible marriage between monistic idealism and pluralistic realism. The Kashmiri Saiva approach understands the world to be a symbol of the absolute, that is, as the manner in which it presents itself to us. Again we can contrast this view with that of the Advaita Vedanta. The Advaita Vedanta understands the world to be an expression of the absolute insofar as it exists by virtue of the absolute's Being. Being is understood to be the real unity which underlies empirically manifest separateness and as such is never empirically manifest. It is only transcendentally actual as 'being-in-itself. The Kashmiri Saiva position represents, in a sense, a reversal of this point of view. The nature of the absolute, and also that of Being, is onceived as an eternal becoming (satatodita), a dynamic flux or Spanda, 'the agency of the act of being'. It is dentified with the concrete actuality of the fact of appearing, not passive unmanifest Being. Appearance (abhasa) alone is real.ppearing (prakasamanatva) is equivalent to the fact of being (astitva). Ksemaraja writes in his commentary on the Stanzas on Vibration: Indeed, all things are manifest because they are nothing but manifestation. The point being that nothing is manifest apart from manifestation The absolutely unmanifest, from this point of view, can have as little existence as the space in a lattice window of a sky-palace. Nay, even less, because even that space can appear as an imagined mage manifest within consciousness. Everything is real according to the manner in which it appears. Even an illusion is in this sense real, insofar as it appears and is known in the manner in which it appears. The empirical and the real are identical categories of thought. As Abhinava says: Thus this is the supreme doctrine (upanisatf), namely that, when- ever and in whatever form [an entity] appears, that then is its particular nature. Perhaps at this stage a brief comparison with Heidegger's ideas might prove to be enlightening and not altogether out of place. According to Heidegger's phenomenology of Being, reality is intelligible in a two-fold Integral Monism of Kashmiri Saivism manner as 'phenomenon' and 'logos'. Heidegger defines what he means by 'phenomenon' as: "that-which-shows-itself. The manifest . . . phenomena are then the collection of that which lies open in broad daylight or can be brought to the light of day — what the Greeks at times implicitly identified as 'ta onta' (the things-which-are)". 127 In his later writings Heidegger drops the term 'phenomenon' in preference for the verbal form 'phainesthai' in order to emphasize even more the actuality or presentational property of Being. Explaining this new form of the term he writes: "Being disclosed itself to the ancient Greeks as 'physis'. The etymological roots 'phy-' and 'pha-' designate the same thing: 'phyein', the rising-up or upsurge which resides within itself as 'phainesthai', lighting-up, self-showing, coming-out, appearing-forth." Heidegger contrasted his notion of phenomenon with semblance (Schein) and with appearing (Erscheinung). In the case of semblance a thing can show itself as that which it is not, as when fool's gold shows itself to be gold. The ancients always allied semblance with non-being. Heidegger points out, however, that semblances are grounded in showings, and so does Abhinava. Both Heidegger and Abhinava consequently maintain that all semblances have a real basis and are to be treated as instances of phenomena along with the so-called real showing or manifestation of non-deceptive objects. So Heidegger states that: 'how- ever much seeming, just that much being'. Thus self-showing or appearing defines Being as phenomenon, but this definition of Being is as yet incomplete. Being is not only self-showing but 'logos' which Heidegger explains means 'discourse' (Rede) in the sense of 'apophansis': 'letting-be-seen'. Phenomenology, which according to Heidegger is the only correct study of Being, means 'letting-be-seen-that-which- shows-itself. This is true of Saiva Paramadvaita as well. The reality of the world demands recognition; we are forced to accept the direct presentation of the fact of our daily experience. As Abhinava says: "if practical life, which is useful to all persons at all times, places and conditions were not real, then there would be nothing left which could be said to be real" A thousand proofs could not make 'blue' other than the colour blue. The reality of whatever appears in consciousness cannot be denied. Objects appear; they do not cease to do so by a mere emphatic denial. The manifestation of an entity in its own specific form is a fact at one level of consciousness; it is real. The appearing of the same entity in the same form but recognised to be a direct representation of the absolute is also a fact, but at another level of consciousness. It is no more or less real than the first. 'As is the state of consciousness, so is the experience,' says Abhinava. Although the nature of the absolute is discovered at a higher level of consciousness, The Doctrine of Vibration nonetheless it presents itself to us directly in the specific form in which we perceive things; otherwise there would be no way in which we could penetrate from the level of appearing to that of its source and basis. Abhinava writes: Real is the entity iyastu) that appears in the moment of direct perception (sak$atkara), that is to say, within our experience of it. Once its own specific form has been clearly determined one should, with effort, induce it to penetrate (e&eb) into its pure conscious nature. All things are known to be just as they present themselves. The concrete actuality of being known (pramiti), irrespective of content, is itself the vibrant (spanda) actuality of the absolute. Liberating knowledge is gained not by going beyond appearances but by attending closely to them. "The secret," Mahesvarananda says, "is that liberation while alive (jivanmukti) is the profound contemplation of Maya's nature." No ontological distinction can be drawn between the absolute and its manifestations because both are an appearing (dbhasa), the latter of diversity and the former of 'the true light of consciousness which is beyond Maya and is the category Siva'. Those who have attained the category of Pure Knowledge above Maya and have thus gone beyond the category of Maya, see the entire universe as the light of consciousness . . . Just as the markings [on a feather] are nothing apart from the feather, the feather [is nothing apart from] them, similarly, when the light of consciousness is manifest, the whole group of phenomena is manifest as the light of consciousness itself. Within the sphere of Maya, every entity's 'own nature' (svabhdva) corresponds to its specific manifest form. Accordingly it is defined as that which distinguishes it from all else and from which it never deviates. Above the sphere of Maya, that is, above the level of objectivity, is the domain of the subject. At this level, everything is realised to be part of the fullness of the experience r and hence no longer bound by the conditions which impinge on the object. Here the part is discovered to be the whole, that is, consciousness in toto. In this sphere beyond relative distinctions, the yogi realises that (all) the categories of existence are present in every single category. m The yogi experiences every individual particular as the sum total of everything else. He recognises that all things have one nature and that every particular is all things. This is the 'essence' (sard) or co-extensive unity (samarasya) of all things. Integral Monism of Kashmiri SaivismWe have established that reality is manifest according to how [and the degree in which] the freedom of consciousness reveals it and that [this freedom] is the womb of all forms. Just as 'sweetness' is present in its entirety in every atom of the sugarcane, so each and every atom [of the universe] bears within itself the emanation of all things. This is the level of consciousness in which the absolute reflects on itself realising to its eternal delight and astonishment (camatkara) its own integral nature. The reality of the world of diversity is not denied, but experienced in a new mode of awareness free of time and space in the eternal omnipresence of the Here and Now. [Phenomenal forms of awareness] such as 'this [exists]', born of the colouring [imparted to the absolute] by the limitations engendered by the diversifying power of time {kalakalana) also emanate within the Supreme Principle. There [at that level], Fullness {purriata) is the one nature [of all things] and so everything is omnipresent; otherwise, associated with division (khancjlana), the Fullness [of the absolute] would not be full. The content of absolute consciousness consists of diverse appearings (abhdsa) which, because they are manifest through it in this way, do not compromise the wholeness of consciousness. Everything we perceive is a momentary collocation of a number of such manifestations which combine together like 4 a row of altar lamps' (dipavalT) to form the single radiant picture of the universe. The individual objects which constitute the universe are specific collocations of such 'atomic' appearings. Together they form (eb) a single unified particular which appears according to its own defining features (svalaksand). A jar, for example, consists of (e) a number of appearances such as 'round', 4 fat\ 'earthen', 'red', etc., which together discharge a single function (arthakriya), in this case, that of carrying the appearance 'water'. They unite with each other much as the scattered rays of a lamp come together when focused, or as the various currents of the sea together give rise to waves. Atomic appearings can combine in any number of ways, provided that they are not contrary to one another as established by the dictates of natural law (niyati). An appearance of 'form', for example, cannot (e) combine with that of 'air'. Insofar as they share a common basis (samanyadhikaranya), a given cluster of appearances appears as a single whole. This common basis is the most prominent member of the group; the appearance 'jar' is such in the example quoted above. Any one appearance in a cluster may assume (eb) a more important or subordinate role. The result is a specific The Doctrine of Vibration awareness of an object of the form: 'here this is (=) such.' While individual appearances do not lose their separate identity {svarupabheda) when they rest on a common basis, even so the particular object which appears according to its own characteristics (svalak$ana) is an individual reality in its own right. It is a different kind of appearance characterised by its association with the appearance of the specific location and time in which it is made manifest. The form of our experience is thus 'I now see this here'. But when we perceive each particular constituent appearance separately, each assumes a separate fixed function. Abhinava cites the following colourful example to illustrate how the various combinations of appearances account for the variety of experience: Thus even though the appearance of the beloved may manifest externally, it is as if far away in the absence of another appearance, namely, that of 'embracing'. So when the [appearing of the beloved] is associated with another appearance [namely that of 'far away'] the power (arthakriya) it formerly had of giving pleasure appears as its contrary. The form our experience assumes depends, not only on the nature of the object perceived, but also on personal factors entirely peculiar to ourselves. This theory explains this in two ways. In one sense, the object remains the same, but one or other of its constituent appearances comes to the fore according to the inclinations of the perceiver. From another point of view, we can say that the perceived object is different for each perceiver according to the difference in the prominent appearance manifest to him. Abhinava, citing as an example a golden jar, illustrates how the same object appears differently to different perceivers according to the use they wish to make of it and to their state of mind: When a person who is depressed and feels that there is nothing [of value for him in the world] sees the jar, he merely perceives the appearance 'exists' [in the form of the awareness that] 'it is\ He is not conscious of any other [of its constituent appearances] at all. An individual who desires to fetch water [perceives] the appearance 'jar'. The man who simply wants something that can be taken somewhere and then brought back [perceives] the appearance 'thing'. The man who desires money [perceives] the appearance 'gold'. The man who desires a pleasing object [perceives] the appearance 'brightness' while he who wants something solid sees the appearance 'hardness'. These 'atomic events' or appearances emerge from the pure subject's consciousness and combine together to form a total event at each moment. Integral Monism of Kashmiri Saivism Daily life (vyavahara) goes on by virtue of this ever renewed flux of appearances. They are connected together and work towards a single unified experience because they appear within the field of consciousness of the universal subject. The aggregate of appearances arises in the [supreme] subject as do [sprouts in] a rice field. Even though each sprout germinates from its own seed, they are perceived as a collective whole. Appearances rest in this way within the universal subject. 'External- ity' is itself another appearance; it arises from a distinction between appearances and the individual subject. So, although all manifestation always occurs within the subject, it appears to be external due to the power of Maya which separates the individual subject from his object. This split must occur for daily life to be possible. Only externally manifest appearances can perform their functions; when they are merged within the subject and at one with him, they cannot do so. Daily life proceeds on the basis of the operation and withdrawal of the conditions necessary for fruitful action to be possible. Appearance in this sense represents the actualisation of a potential hidden in consciousness made possible by virtue of its dynamic, Spanda nature which is both the flow from inner to outer and back as well as the power that impels it. The emergence from, and submergence into, pure consciousness of each individual appearance is a particular pulsation (visesaspanda) of differentiated awareness. Together these individual pulsations constitute the universal pulse (samanyaspandd) of cosmic creation and destruction. Thus, every single thing in this way forms a part of the radiant vibration {sphuratta, sphurana) of the light of absolute consciousness. Light and Awareness: The Two Aspects of Consciousness Absolute consciousness understood as the unchanging ontological ground of all appearing is termed 'Prakasa'. As the creative awareness of its own Being, the absolute is called ' Vimarsa '. Prakasa and Vimarsa — the Divine Light of consciousness and the reflective awareness this Light has of its own nature — together constitute the all-embracing fullness (purnata) of consciousness. The Recognition (pratyabhijfia) school of Kashmiri Saivism develops this concept of the absolute which finds its fullest expression in Utpaladeva's Stanzas on the Recognition of God. Even though neither of these two key terms appear in the Stanzas on Vibration or the Aphorisms of Siva, they recur frequently in their commentaries. Thus, although the original formulation of the Doctrine of Vibration differs from the theology of Recognition in this respect, it was extended in the course of its development to accommodate this concept of the absolute as well. This was possible, and quite justified, insofar as the absolute understood in Pratyabhijfia terms does not, as we shall see, differ essentially from that of the Spanda school. We can, as Kashmiri Saivites themselves have done, explain one in terms of the other. The Doctrine of Vibration Prakasa: The Light of Consciousness Prakasa is the pure luminosity' (bhdna) or 'self-showing' that constitutes the essence and ultimate identity (atman) of phenomena. That things appear at all is due to the light of consciousness, and their appearing (avabhasana) is itself this Light which bestows on all things their evident, manifest nature. Established in the light of consciousness everything appears there according to its own specific nature (svabhava). Anything that supposedly does not rest in this Light is as unreal as a sky-flower. 3 Thus, according to Rajanaka Rama, unlike the light of the sun, or any other light, this Light not only makes all things apparent, it is also their ultimate source. 4 Full of its divine vibration the Light makes all things manifest and withdraws them into itself. This supra- temporal activity characterises it most specifically; devoid of it, it would be no better than an inert physical phenomenon. At the same time, this light is the conjunction (slesa) or oneness (aikdtmya) of its countless manifest forms, 6 and the collective whole (Sampina'ana) of all the categories of existence. The universe is nothing but the shining of the Light within itself. It is the radiant vibration (sphuratta) of this Light, the state (avast hand) in which consciousness becomes manifest. Although the Light shines as all things at all times and hence also makes their diversity manifest, 9 penetrating each object individually as well as collectively, it is not totally 'merged' (magna) or identified with the object so as to suffer any division within itself. Our experience of any object is of the form: T see this': it is not itself an object, but the manifest form the object assumes as a luminous principle of experience. The Light is ever revealed and can never be obscured; objectivity can never cast a shadow on the light of consciousness. The Stanzas on Vibration declare: That in which all this creation is established and from whence it arises is nowhere obstructed because it is unconditioned by [its very] nature. This Light is the highest reality (Paramartha). It is the 'Ancient Light' (puranaprakasa) that makes all things new and fresh every moment. It is 'always new and secret, ancient and known to all'. It is the form of the Present (vartamanarupa), the Eternal Now. Time and space are relations between the contents of consciousness; they cannot impinge on the integrity of the absolute itself. 16 Neither space nor time can divide it, for they are one with the Light that illumines them Light and Awareness: Two Aspects of Consciousness and makes them known as elements of experience. But this Light is the shining of the absolute; it is not an impersonal principle. It is the living Light of God, indeed it is God Himself, the Master Who instructs the entire universe. 18 Siva is this 'auspicious lamp', Who illumines all things. He is the Light of consciousness that reveals the presence of both the real and the unreal, of light' and 'darkness'. 20 Abhinavagupta writes: Thus Bhairava, the Light, is self-evident (svatahsiddha); without beginning, He is the first and last of all things, the Eternal Present. And so what else can be said of Him? The unfolding of the categories of existence (tattva) and creation, which are the expansion of His own Self, He illumines, luminous with His own Light, in identity with Himself, and because He illumines Himself, so too He reflects on His own nature, without His wonder (camatkara) being in any way diminished. Although It Is Possible To Catch Glimpses Of The Highest Reality In Advanced States Of Contemplation Before Attaining Perfect Enlightenment, These States, However Long They Last, Are Transitory (Kadacitka) And When They End The Vision Of The Absolute Ceases With Them. The Highest Realisation, However, Persists In All States Of Consciousness. It Happens Once And Need Never Occur Again. A Passage From A Lost Tantra Declares: "The Self Shines Forth But Once, It Is Full [Of All Things] And Can Nowhere Be Unmanifest." All Spiritual Discipline Culminates In This Moment Of Realisation. Accordingly, Abhinava Stresses That The Goal Of All The Means To Realisation, Even The Individual Means, Is This Absolute Consciousness. Finally, It Is Worth Noting That Although Abhinava Affirms That The Teachings Concerning Anupaya Are Found In The Siddhayogesvarimata And The Malinxvijaya, Both Of Which, According To Abhinava, Are Major Tantras Of The Trika School, It Is In The Theology Of The School Of Recognition That It Is Best Exemplified. Abhinava Himself Refers To Somananda, The Founder Of This School, As Teaching It And Alludes To The Following Passage In The Vision Of Siva To Support His Own Exposition: When Siva, Who Is Everywhere Present, Is Known Just Once Through The Firm Insight Born Of Right Knowledge (Pramana), The Scripture And The Master's Words, No Means [To Realisation] Serves Any Purpose And Even Contemplation {Bhavana) [Is Of No Further Use]. Anupaya Is Therefore, According To Abhinavagupta, The Recognition Of One's Own Authentic Siva-Nature, Which All The Higher Tantric Traditions Teach Is The Ultimate Realisation. This Is Also True Of The Doctrine Of Vibration Whose Precedents Are Clearly Traceable To These Same Traditions. Thus, Although The Stanzas Themselves Never Refer Directly To Enlighten- Ment As An Experience Of Recognition, There Can Be Little Doubt That Spanda Practice Leads To This Same Realisation. Accordingly, Commentators Stress That We Realise The Vibration Of Consciousness By Recognising Its Activity And That Liberation Depends On The Recognition Of This As One's Own Nature. Ksemaraja Describes What Happens In This Moment Of Recognition According To The Doctrine Of Vibration Thus: At The End Of Countless Rebirths, The Yogi's [Psycho-Physical] Activity [Which Issues From Ignorance] Is Suddenly Interrupted By The Recognition Of His Own Transcendent Nature, Full Of A Novel And Supreme Bliss. He Is Like One Struck With Awe. And In This Attitude Of Astonishment (Vismaya- Mudra) Achieves The Great Expansion [Of Consciousness] {Mahavikasa). Thus He, The Best Of Yogis, Whose True Nature Has Been Revealed [To Him] Is Well Established [At The Highest Level Of Consciousness], Which He Grasps Firmly And His Hold Upon It Never Slackens. Thus He Is No Longer Subject To Profane Existence (Pravftti), The Abhorrent And Continuing Round Of Birth And Death, Which Inspires Fear In All Living Beings, Because Its Cause, His Own Impurity, No Longer Exists. The Divine Means (Sambhavopava) In Anupaya The Yogi Does Not Need To Deal With The World Of Diversity At All; Only Paramasiva Exists There. Beyond Both Immanence And Transcendence, He Has Nothing To Do With The World Of Practice And Realisation. Anupaya Is The Experience Of The Undefinable (Qnakhya) Light Of Consciousness, Which Is The Pure Bliss Beyond Even The Supreme State (Paratlta) Of Sivatattva. At A Slightly Lower Level, Corresponding To The Divine Means, A Subtle Distinction Emerges Between The Goal And The Path. The Yogi Now Practises Within The Domain Of The Outpouring Of The Power Of Consciousness. From This Level He Penetrates Directly Into The Universal Egoity Of Pure Consciousness By The Subtle Exertion (Udyama) Of Its Freedom (Svatantrya) And Reflective Awareness. The Yogi Who Practises The Divine Means Is Not Concerned With Any Partial Aspect Of Reality But Centers His Attention Directly On Its Abounding Plenitude. Hence This Means Is Based On Siva's Own State (Sambhavavastha) In Which Only The Power Of Freedom Operates As The Pure Being (Satta) Or Essence Of All The Other Powers. This State Is The Light Of Consciousness Which, Free Of All Thought- Forms, Is The Basis Of All Practice." The Yogi Who Recognises That Pure Consciousness, Free Of Thought-Constructs (Nirvikalpa), Is His Basic State, Can Practice In Any Way He Chooses; Even The Most Common Mantra Will Lead Him Directly To The Highest State. Thus The Forms Of Contemplative Absorption, Empowered (Sakta) And Individual (Anava), Which Are The Fruits Of The Other Means To Realisation Both, Attain Maturity In This Same Undifferentiated Awareness. This Awareness Is The Pure Ego Manifest At The Initial Moment Of Perception (Prathamikalocana), When The Power Of The Will To Perceive Is Activated. It Is The Subtle State Of Consciousness That Reveals The

Presence And Nature Of Its Object Directly: That Which Shines And Is Directly Grasped In The First Moment Of Perception While It Is Still Free Of Differentiated Representations And Reflects Upon Itself Is [The Basis Of The Divine Means] Said To Be The Will. Just As An Object Appears Directly To One Whose Eyes Are Open Without The Intervention Of Any Mental Cogitation (Anusaipdhana), So, For Some, Does Siva's Nature. The Movement Of Awareness At This Level Of Practice Attains Its Goal Quickly. While Consciousness Is Heightened Progressively In The Other Means, Here It Expands Freely To The Higher Levels, Unconfined By Any Intruding Thought-Constructs. The Divine Means Is A 'Thoughtless Thought', A 'Processless Process', That Occurs At The Juncture Between Being And Becoming. Abhinava Explains: When The Heart [Of Consciousness] Is Pure And [Free Of Thought- Constructs], It Harbours The Light Which Illumines The Radiant, Primordial Plane Ipragrabhumi) Together With All The Categories Of Existence. [The Yogi] Then Realises Through It His Identity With Siva Who Is Pure Consciousness The Yogi Must Catch The Initial Moment Of Awareness (Adiparamarsa) Just When Perception Begins^ He Must Not Move On From The First Pure Sensation Of The Object But Return To Its Original Source In His Own T Consciousness. Observing In This Way The Objective Field Of Consciousness Without Laboring To Distinguish Particulars, The Yogi Penetrates Into His Own Subjectivity Which, Vacuous And Divested Of All Outer Supports (Niralamba), Is Not Directed Anywhere Outside Itself (Ananyamukha- Preksin). Here He Can Hold Of The Power Inherent In His Own Consciousness Through Which He Discerns The True Nature Of Whatever Appears Before Him. Thus The Stanzas On Vibration Teach: Just As An Object, Which Is Not Seen Clearly At First Even When The Mind Attends To It Carefully, Becomes Later Fully Evident When Observed With The Effort Exerted Through One's Own [Inherent] Strength (Svabala), In The Same Way, When [The Yogi] Lays Hold Of That Same Power, Then Whatever [He Perceives Manifests To Him] Quickly According To Its True Nature, Whatever Be Its Form, Locus, Time Or State. Thus, Although The Practice Of This Divine Means Starts By Catching Hold Of The Will In The First Moment Of Awareness, It Also Concerns The Second And Third Moments In Which The Means Of Knowledge And The Object Are Made Manifest. When Practice At This Level Proceeds Smoothly And Without Interruption, The Three Powers Of Will, Knowledge And Action Fuse Into The Trident (Trisula) Of Power, Which Is The Subject Free Of All Obscuration (Niranjana), M At One With The Power Of Action In Its Most Powerful And Evident Form. The Kaula Schools Call This State The Stainless (Niranjanatattva). Equated In The Spanda Tradition With The Dawning Of The Vibration Of Consciousness {Spandodaya), It Is The Enlightenment The Spanda Yogi Seeks. Spanda Practice Is Based On The Experience Of Spanda Which, As We Have Seen, Is Defined As The Intent (Aunmukhya) Of Consciousness, Unrestricted To Any Specific Object And Hence Free Of Thought-Constructs. Spanda Can Therefore Be Experienced Directly When A Powerful Intention Develops Within Consciousness, Whatever Is Its Ultimate Goal Or Cause. We Have Already Noted That Intense Anger, Joy, Grief Or Confusion Is Such Occasions. Similarly, The Yogi Can Make Contact With The Omnipotent Will, Which He As Siva Possesses, Through Intense Prayer. Directing His Entire Attention To Siva, The Benefactor Of The World, Entreating Him Fervently And Without Break, His Will Merges With Siva's Universal Will, Which Is The Source Of Every Impulse And Perception. As He Looks About Him, The Yogi Realises That It Is Siva Himself, The Universal Consciousness And The Yogi's Authentic Identity, Who Ordains His Every Action, Thought And Perception. Thus The Yogi's Cognitive Intent On His Object Coincides With The Universal Will To Make That Object Known To Him, Whether The Yogi Is Awake Or Dreaming. He Is Thus No Longer Like The Worldly Man Who Cannot Dream As He Wishes And Is Forced To Experience Whatever Spontaneously Happens In These States Of Consciousness. Ultimately The Yogi Manages, By Siva's Grace, To Maintain A Constant Awareness Of His Own Pure Perceptive Consciousness (Upalabdhrta) Divested Of All Obscuring Thought-Constructs In Deep Sleep As Well As In The Contemplative State (Turiya) Beyond It. When He Rises To The Higher Levels Of Contemplation In Which The Breath Is Suspended And All Sensory And Mental Activity Ceases, The Yogi Who Manages To Sustain This Pure, Undifferentiated Awareness Does Not Succumb To Sleep As Do Less Developed Yogis. Perfection In The Practice Of The Divine Means Thus Coincides With The Goal Of Spanda Practice, Namely, A Constant, Alert Attention To The Perceiving Subjectivity Which Persists Unchanged In Every State Of Consciousness Both As The Perceiver And Agent Of All That It Experiences. Another Important Spanda Practice Belonging To This Means Is Centering. The Spanda Yogi Seeks To Find The Centre (Madhya) Between One

Cognition And The Next; For It Is There That He Discovers The Expansion (Unmesd) Of Consciousness Free Of Thought-Constructs From Whence All Differentiated Perceptions (Yikalpa) Emerge. 107 Abhinava Explains That This Pure Awareness Is Called: . . . The Expansion (Unme$a) Of [Consciousness] Or The Creative Intuition {Pratibha) [Experienced] In The Interval Which Divides Two [Moments] Of Differentiated Perception (Vikalpa). It Is Here That They Arise And Disappear. The Sastras And Agamas Proclaim With Reasoned Argument That It Is Free Of Thought-Constructs {Nirvikalpa) And Precedes All Mental Representations Of Any Object. None Can Deny That A Gap Exists Between Perceptions Insofar As Two Moments Of Thought Are Invariably Divided. This [Gap] Is The Undifferentiated Unity Of All The Countless Manifestations. Similarly, In The Outer More Objective Sphere, Where Change Consists Of The Alterations In The Configurations Of Manifest Appearances (Abhasa\ The Transition From One To Another Corresponds To A Phase Of Pure Luminosity That Marks The Beginning Of One Form And The End Of Another. The World Of Manifestation And Differentiated Perceptions (Yikalpa) Thus Extends From One Centre To The Next. Although It Is Never In Fact Divorced From The Subject Who Resides There, The Ignorant Fail To Grasp This Fact And So, Cut Off From The Centre, The World Of Objectivity Becomes For Them The Sphere Of Maya. Bhagavatotpala Quotes The Light Of Consciousness (Samvitprakdsa): This Ever Pure Experience (Suddhanubhava) Is Variegated By Each Form [Revealed Within It]; Even So It Remains Unstained (Nirmala) When Moving To Another. Just As A Cloth Which Is Naturally White, Once Dyed, Cannot Change (e&eb) Colour Without [First] Becoming White Again, Similarly The Pure Power Of Awareness, (Citi) Once Coloured By Form, Is Pure [Again] At The Centre Where That Form Is Abandoned And From Whence It Proceeds To Another. In His Essence Of Vibration (Spandasarpdoha), K§Emaraja Explains That The Rise And Fall Of Every Individual Perception In The Field Of Awareness Is A Specific Pulsation Of Consciousness. From The Point Of View Of The Object, The Expansion (Unmesa) Of This Pulse Is Represented By The Initial Desire To Perceive (Didrksa) A Particular Object, While The Contracted (Nimesa) Phase Is The Withdrawal Of Attention From The Object Previously Perceived. From The Point Of View Of The Perceiving Subjectivity, The Phases Are Reversed, So That The Initial Desire To Perceive Marks The Contraction (Nimesa) Of Subjective Consciousness While The Falling Away Of The Previous Perception Is Its Expansion (Unmesa). At The Higher Level, Where These Two Phases Are Experienced Within Consciousness, They Represent The State Of The Categories Of Isvara ('This Universe Is Me') And Sadasiva ('I Am This Universe'). Utpaladeva Says: Expansion (Unme$A\ Which Is In The External Manifestation [Of Objectivity], Is Kvaratattva While Contraction (Nime$A), Which Is In The Internal Manifestation [Of Subjectivity], Is Sadasiva. At This Level All The Powers Of Consciousness Fuse And Both Phases Are Manifest As Part Of One Reality. This Unity Is In Fact Apparent To Everybody At Each Moment. However, Within The Domain Of Maya, Which Is The Sphere Of Differentiated Perceptions (Yikalpa), It Is Clearly Manifest Only At The Juncture (Madhya) Between Two Cognitions. In This Centre Resides The Void (Kha) Of Consciousness (Free Of Thought-Constructs) Which, Divested Of Diversity, Digests Into Itself All The Psycho-Physical Processes That Give Life To The Multiplicity Of Perceptions. The Yogi Moves From The Particular Vibrations Of Consciousness At Its Periphery To The Universal Throb Of The Heart In The Centre. As Abhinava Explains: The Self-Reflective Awareness In The Heart Of Pure Consciousness, Present At The Beginning And End Of Each Perception, Within Which The Entire Universe Is Dissolved Away Without Residue, Is Called In The Scriptures, The Universal Vibration Of Consciousness (Samanyaspanda) And Is The Outpouring (Uccalana) [Of Awareness] Within One's Own Nature. All The Categories Of Existence (Tattvas) Are United In The Heart Of The Centre Where The Life-Giving Elixir Of Siva's Consciousness Floods One's Own Inner Nature. To Reside In The Centre Is To Abide By The Law Of Totality (Gramadharma) In A State Which Transcends The Workings Of The Mind (Unmana). Consciousness (Jnana) With Light As Its Support, Residing In The Centre Between Being And Non-Being Is Known As The Act Of Abiding In One's Own Abode As The Perceiving Subjectivity (Dratfrtva) Free Of All Obscuration. That Which Has Been Purified By Pure Awareness (Suddhavijnana) Is Called The Transcendent (Viviktavastu), Said To Be The Mode Of Being (V/7//) Of The Law Of Totality (Gramadharma) Through Which Everything Is Easily Attainable. The Power In The Centre (Madhyasakti) Is The Eternal Present. Beyond Time It Is The Source Of Both Past And Future. To Be Established There Is To Abide Without A Break In Rama, The Supreme Enjoyer, In Every Action Of One's Life. Rama Is Siva, The Supreme Cause Who Pervades The

Fourteen Aspects Which Embrace The Entire Universe Of Experience, Namely, Moving, Standing, Dreaming, Waking, The Opening And Closing Of The Eyes, Running, Jumping, Exertion, Knowledge [Born] Of The Power Of The Senses, The [Three] Aspects Of The Mind, Living Beings, Names And All Kinds Of Actions. By Developing An Awareness Of The Centre, The Yogi Experiences The Bliss Of Consciousness. Through This Gap He Plunges Into Introverted Absorption (Nimilanasamadhi) And Then Emerges Again To Pervade The Field Of Awareness Between Centres And So Experience The Cosmic Bliss (Jagadananda) Of The Universal Vibration Of Consciousness. 1 I8 He Then Recognises That This State Pervades Every Aspect Of Experience. In This Way The Yogi's Consciousness Is No Longer Afflicted By The Power Which Obscures It, Hemming The Centre In On Both Sides With Thought-Constructs That Seemingly Deprive It Of Its Fullness. As He Realises Directly His Pure Conscious Nature As The Universal Ego Free Of All Mental Representations, It Expands Out To Embrace All Things Within Itself. Thus The Realisation The Divine Means Leads To, And Is Directly Based Upon, Is That This Pure Ego Is In All Things Just As All Things Are Within It. In The Spanda Tradition, As Recorded In The Stanzas On Vibration, No Such Ego Is Recognised. ' I9 Man's Authentic Nature Is, However, Understood In Personal Terms As Every Individual's Own 'Own Nature* (Svasvabhava) Which Is Siva, The Universal Vibration Of Pure Subjectivity (Upalabdhfta). It Is Not Surprising, Therefore, That Later Commentators Found These Two Conceptions To Be Essentially The Same And Accordingly Identified One's Own Inner Nature With The Pure Ego. This Came As A Natural Development In Spanda Doctrine Not Only For This Reason But Also Because The Universal Ego Is Experienced As The Inner Dynamics Of Absolute Consciousness. To Conclude Our Summarial Exposition Of The Divine Means, Which Is Centred On The Direct Experience Of This Pure Ego (And Hence On Spanda In This Form), We Turn Now To A Brief Description Of Its Inner, Cyclic Activity. We Shall Do This By Examining Abhinava' S Esoteric Exegesis Of The Symbolic Significance Of The Word 'A HAM', Which In Sanskrit Means T, And Symbolises By Its Form The Ego's Dynamic Nature. The Objective World Of Perceptions Is, As We Have Seen, Essentially A Chain Of Thought-Constructs (Prapanca) Closely Linked To One Another And Woven Into The Fabric Of Diversity (Vicitrata). This Thought (Vikalpa) Is (=) A Form Of Speech (Vac) Uttered Internally By (e) The Mind (Citta), Which Is Itself An Outpouring Of Consciousness. Consciousness Also, In Its Turn, Resounds With The Silent, Supreme Form Of Speech {Para Vac) Which Is The Reflective Awareness Through Which It Expresses Itself To Itself. Consequently, The Fifty Letters Of The Sanskrit Alphabet, Which Are The Smallest Phonemic Units Into Which Speech Can Be Analysed, Are Symbolic Of The Principal Elements Of The Activity Of Consciousness. Letters Come Together To Generate Words And Words Go On To Form Sentences. In The Same Way The Fifty Phases In The Cycle Of Consciousness Represent, In The Realms Of Denoted Meaning (Vacya), The Sum Total Of Its Universal Activity (Kriya) Corresponding To (e&eb) The Principal Forces (Kala) Which Come Together To Form The Metaphysical Categories Of Experience, Which In Their Turn Appear In The Grossest, Most Explicitly 'Articulate' Form As The One Hundred And Eighteen World-Systems (Bhuvana). 'A', The First Letter Of Both AHAM And The Sanskrit Alphabet, Is The Point Of Departure Or Initial Emergence Of All The Other Letters And Hence Denotes Anuttara — The Absolute. 'Ha', Is The Final Letter Of The Alphabet And Represents The Point Of Completion When Ail The Letters Have Emerged. It Represents The State In Which All The Elements Of Experience, In The Domains Of Both Inner Consciousness And Outer Unconsciousness, Are Fully Displayed. It Is Also The Generative, Emission (Visarga) Which, Like The Breath, Casts The Inner Into The Outer, And Draws What Is Outside Inward. The Two Letters 'A' And 'Ha' Thus Represent Siva, The Transcendental Source And Sakti, His Cosmic Outpouring That Flows Back Into Him. The Combined 'A-Ha' Contains Within Itself All The Letters Of The Alphabet — Every Phase Of Consciousness, Both Transcendental And Universal. (For A Graphic Representation Of This Analysis, See Figure 1.) M, The Final Letter Of AHAM, Is Written As A Dot Placed Above The Letter Which Precedes It. It Comes At The End Of The Vowel Series And Before The Consonants And So Is Called 'Anus Vara '(Lit. 'That Which Follows The Vowels') And Also 'Bindu ' (Lit. 'Dot,' 'Drop,' 'Point' Or 'Zero'). While The Consonant 'M' Symbolises The Individual Soul (Purusa), 'Bindu 1 Rep Resents The Subtle Vibration Of T, Which Is The Life Force (Jivakala) And Essence Of The Soul's Subjectivity Manifest At The Transcendental, Supra-Mental Level (Unmana). 12 ° It Is The Zero-Point In The Centre Between The Series Of Negative Numbers, In This Case The Vowels Which Represent The Processes Happening Internally Within Siva, And The Series Of Positive Numbers — The Consonants Which Symbolise The Processes Happening Externally Within Sakti. Bindu, As A Point Without Area, Symbolises The Non-Finite Nature Of The Pure Awareness (Pramitibhava) Of AHAM. It Is The Pivot Around Which The Cycle Of Energies From 'A' To 'Ha' Rotates, The Void In The Centre From Which All The Powers Emanate And Into Which They Collapse. As Such, It Is The Supreme Power Of Action Which Holds Subject, Object And Means Of Knowledge Together In A Potential State In The One Light That Shines As All Three Containing Them In Its Repose (Visrdnti). Bindu Is The 'Knower' (Jndtr), Who Is Essentially Consciousness That, Though Omniscient, Does Not Manifest Its Intelligence, Like A Man Who Knows The Scriptures But Having No Occasion To Explain Them To Others Silently Bears This Knowledge Within Himself. As Such, It Symbolises The Union Of Siva And Sakti (Sivasakti- Mithunapina'a) In A State Of Heightened Potency In Which They Have Not Yet Divided To Generate The World Of Diversity. It Stands, In Other Words, At The Threshold Of Differentiation In The Stream Of Emanation Still Contained Within Siva. The Absolute. Expansion Commences Bindu — The Individual Soul Withdrawal Commences Then, To The Degree In Which That Which Is To Be Accomplished By The Power Of Action Residing Within It [As A Potential] Penetrates Into The Absolute, It Appears Initially As Bindu, Which Is The Light Of Pure Consciousness. When Outer Objectivity Is Reabsorbed Into Its Transcendent Source, Bindu Is The Point Into Which All The Manifest Powers Of Consciousness Are Gathered And Fused Together. The Universal Potency Of All The Letters Is Thus Contained In Bindu Which, As The Reflective Awareness Of Supreme T Consciousness, Gives Them All Life. Thus Bindu Also Marks The Beginning Of Siva's Internal Movement Back To The Undifferentiated Absolute And So Stands At The Threshold Of Both Emission And Absorption Without Being Involved In Either. The Three Aspects Of AH AM Together Constitute A Movement From The Undifferentiated Source Of Transcendental Consciousness — 'A' — Through The Expansion Or Emission Of Its Power — 4 Ha' — To The Subject — 'M 1 —Which Contains And Makes Manifest The Entire Universe Of Experience. The Reverse Of This Movement, That Of Withdrawal (Samhara), Is Represented By M-Ha-A. AHAM And M-Ha-A Alternate In The Rotation (Ghurnana) Of The Reflective Awareness Of T Consciousness As Immanent Sakti Emerges From Transcendental Siva To Then Merge Back Into Him. As Abhinava Says: The Universe Rests Within Sakti And She On The Plane Of The Absolute (Anutiara) And This Again Within Sakti ... For The Universe Shines Within Consciousness And [Consciousness Shines] There [Within The Universe By The Power Of] Consciousness. These Three Poles, Forming A Couple And Merging, Make Up The One Supreme Nature Of Bhairava Whose Essence Is AHAM- At The Microcosmic Level, Fc A' Represents The Initial Moment When The Subject Begins To Rise Out Of Himself To View The Object. The Movement From 'A To 'Ha' Marks The Emergence Of Sensation Within The Field Of Awareness, Which Is Represented By The Fifty Letters Of The Alphabet Symbolic Of The Fifty Aspects Of The Flux Of Consciousness Leading To Objectified Perception. 'Nl' Is Tne Subject Who, Resting Content Within Himself When He Has Perceived His Object Merges Through The Inner Flow Of Awareness Into K A\ The Absolute. Then From The Absolute (A) Its Emission (Ha) Flows Back Into The Pure Subject (M) Set To Perceive His Object. Thus All The Cycles Of Creation And Destruction Are Contained Within AHAM Through Which They Are Experienced Simultaneously As The Spontaneous Play Of The Absolute. The Yogi Who Recognises This Recurrent Pulse Of Awareness To Be The Movement Of His Own Consciousness Merges His Limited Ego With The Universal Ego. Thus He Realises That Its Power To Create, Sustain And Destroy All Things Is His Own Inner Strength (Svabaia) That He Exerts Effortlessly In The Same State Of Mystical Absorption (Turlya) In Universal Consciousness That The Absolute Itself Enjoys. In This Way He Shares In The Three-Fold Awareness Siva Himself Has Of His Own Nature Which Abhinava Describes As Follows: I Make The Universe Manifest Within Myself In The Sky Of Consciousness. I, Who Am The Universe, Am Its Creator! ' — This Awareness Is The Way In Which One Becomes Bhairava. 'AH Of Manifest Creation(Sadadhvari) Is Reflected Within Me, I Cause It To Persist 1 — This Awareness Is The Way In Which One Becomes The Universe. The Universe Dissolves Within Me. I Who Am The Flame Of The [One] Great And Eternal Fire Of Consciousness' — Seeing Thus One Achieves Peace. The Experience Of The Liberated Thus Coincides With The Realisation Of Their Own Divine Nature Which, Through Its Power, Rules And Guides The Cosmic Order. Thus This Attainment (Siddhi), Which Is Liberation Itself, Is In The Doctrlie Of Vibration Technically Called 'Mastery Over The Wheel Of Energies' (Cakresvaratvasiddhi) Because The Liberated

Soul, Identified With Siva, Now Governs, As Does Siva, The Cycle Of The Powers That Bring About The Creation And Destruction Of All Things, The Empowered Means (Saktopaya) All The Practices Taught In The Stanzas On Vibration Are Internal. Whenever Ritual Is Mentioned, It Is Invariably Interpreted In Terms Of The Dynamics Of The Inner Processes The Yogi Experiences And Implements In The Course Of His Yogic Practice. The Doctrine Of Vibration, Ksemaraja Affirms, Is Concerned Entirely With These Inner Disciplines Centred, As It Is, In One Way Or Another, On Consciousness Or, At Least, On The Inner Activity Of The Mind. Thus The Empowered Means Which, Like The Other Categories We Have Discussed, Is Entirely Internal Includes An Important Part Of Spanda Practice. Spanda Practice Belonging To The Divine Means Centres On One's Own Inherent Nature (Svasvabhava) As Siva, The Universal Perceiver And Agent, That Belonging To The Empowered Means On His Power Instead Of Arriving Directly At The All-Embracing Emptiness Of Subjective Conscious- Ness, The Yogi Practising The Empowered Means Realises His True Nature Through The Fullness Of Its Energy. Practising The Divine Means, The Yogi Plunges, As It Were, Straight Into The Fire Of Consciousness; Practising The Empowered Means He Merges With Its Rays. Either Way The Yogi Is Centred Equally On Ultimate Reality. The Power Of Consciousness Is No Less Absolute Than Its Possessor. To Make This Point Abhinava Quotes The Matanga- Tantra: This Reality Consists Of The Rays Of [Siva's] Power And Is Variously Said To Be The Abode Of The Lord's Manifestation . . . That Same [Power] Illumined [By Siva] Is Itself Also Luminous, Unshaken And Unmoving. That Very [Power] Is The Supreme State, Subtle, Omnipresent, The Nectar Of Immortality, Free Of Obscuration, Peaceful, Yearning For Pure Being Alone {Vastumatra) And Devoid Of Beginning And End. Perfectly Pure, It Is Said To Be The Body [Of Ultimate Reality]. The Yogi Concentrates On The Powers Operating In All Of Life's Activities As Particular Pulsations (Visesaspanda) In The Universal Rhythm (Samanyaspanda) Of The Power Of Consciousness. In This Way He Rises Progressively From The Particular To The Universal Until He Reaches Pure Being (Satta), The Greatest Of All Universals (Mahasamanyd) And The Highest Form Of Siva's Power. Thus The Creative Power Of Maya, Manifest Through Countless Lesser Powers, No Longer Causes The Yogi To Stray From Siva's Consciousness But Becomes The Means Through Which It Can Be Realised In The Illuminating Brilliance (Sphuratta) Which Is Siva's Pure Being. Thus By Discovering The True Nature Of Sakti, The Yogi Realises Himself To Be Siva, Its Possessor Who Consists Of All Its Countless Powers. Thus Practise Belonging To This Means Leads To The Same Pure Consciousness Free Of Thought-Constructs Realised Through The Divine Means. Although The Ultimate Realisation Is Instantaneous, The Yogi Rises To It Gradually By Freeing His Consciousness Of The Limitations Imposed Upon It By Thought. Abhinava Explains: The Same Occurs In The Empowered Means [As Does In The Divine]. At The Discursive Level Of Consciousness {Yaikalpikibhumi) [Where The Empowered Means Functions] Knowledge And Action, Although Evident, Are, For The Reasons Explained Previously, Contracted. A Blazing Energy [Is Revealed Within] The One Who Dedicates Himself To Removing The Burden Of This Contraction. [This Energy Eventually] Brings About The Inner Manifestation {Antarabhasa) Of Pure Consciousness He Seeks. Consciousness Is Individualized And Its Power Of Knowledge And Action Contracted By The Thought-Constructs Born Of Ignorance. The Arising Of These Mental Representations, As The Stanzas On Vibration Say, Deprives The Soul Of Its Freedom And Immortal Life. The Practise Of The Empowered Means Is Meant To Free The Fettered Soul Of This Constriction On His Consciousness. It Operates Within The Mental Sphere (Cetasy™ And Is Designed To Purify Thought (Vikalpasamskara) In Order To. Reveal The Pure Consciousness Which Is Its Ground And Ultimate Source. Thus, The Empowered Means Is Concerned With The Second Instant Of Perception, During Which The Subject Forms Mental Representations Of His Object. Thought Functions On The Basis Of An Awareness Of Relative Distinctions Between Specific Particulars, Distinguishing Them From One Another And Thus Seemingly Fragmenting The Essential Unity Of Reality. The Vibrant Vitality Of Consciousness, Universally Manifest, Is Clouded Like A Mirror By A Child's Breath And The Soul Is Deprived Of The Liberating Intuition Of The One Reality Free Of Thought-Constructs (Nirvikalpa). Abhinava Writes: The [Fettered Soul] Is Like A Dancing Girl Who Although Wishing To Leave The Dancehall Is Collared By The Doorkeeper Of Thought And Thrown Back Onto The Stage Of Maya All Thought Is Centred On Objectivity And Hence Dislodges Awareness From The Plenitude Of Pure Subjective Consciousness. Thus, To Regain The Original State Of Rest (Visranti) Consciousness Enjoys, The Yogi Must Rid Himself Of Thought. As Thought-Forms

Decrease, Pure, Thought-Free Awareness Is Strengthened Until The Yogi Is Fully Established In A State In Which The Relative Distinctions (Bheda) Conceived Between Entities Dissolve Away. Everything Appears To Him As Pure Being (Sattdmdtra) L} And The Entire Universe Shines Before Him Pervaded By Siva's Radiance. His Intuitive Faculty (Mati) Thus Purified, The Yogi Gains Both The Perfections (Siddhi) Of Yogic Practice And Liberation (Mukti). His Consciousness Is Now Like A Well-Polished Mirror Which Reflects Everything He Desires And Grants It To Him. Abhinava Writes: Just As A Man Who Has Been Ill For A Long Time Forgets His Past Pain Completely When He Regains His Health, Absorbed As He Is In The Ease Of His Present Condition, So Too Those Who Are Grounded In Pure Awareness Free Of Thought-Constructs Are No Longer Conscious Of Their Previous [Fettered] State. Consciousness, The Sole Truly Existent Reality, Free Of Thought- Constructs Is Made Fully And Evidently Manifest By Eliminating These Differentiated Perceptions. The Wise Man Should Therefore Exert Himself To Attend Closely To This [State Of Awareness]. The Thought-Constructs Generated Within Consciousness Do Not In Reality Affect It At All. They Can Neither Break Up Nor Add Anything To The Light Which Shines As All Things. They Are In Fact Nothing But Consciousness Itself Which Perceives, Through Its Power Of Reflective Awareness (Yimarsa), The Multitude Of Objects In Diverse Ways, And So Assumes This Form. Although Thought-Constructs Are Mental Representations Of Objects Once Seen Or Present, They Are Products Of The Power Of Consciousness And Not Of The Objects They Represent. Thought Is Both Analytic And Synthetic; It Serves The Useful Purpose Of Separating Individual Elements Of Experience From Others And Linking Together Those That Appear To Be Distinct From One Another So That They Can Be Better Understood. It Does Not Consist Merely Of False Mental Constructs Projected Onto Reality That Need To Be Wholly Rejected. Thought Obscures Consciousness And Distracts It Only When It Appears In The Form Of Doubt, Vacillating Between Alternatives. Once This Conflicting Duality (Dvaitddhivasa) Is Eliminated, Thought Is Purified And Rests In Itself As The 'Thought-Less Thought' Of Pure Consciousness. By Gradually Eliminating The Multitude Of Conflicting Notions That Agitate Him, The Yogi Ultimately Achieves The Certainty (Niscaya) Corresponding To A Direct Awareness Of His Own Divine Nature. Abhinava Explains: Thought Is In Reality None Other Than Pure Consciousness. Even So, It Serves As A Means To Liberation For The Individual Soul (Anu) Only When It Takes The Form Of Certainty (Niscaya). This surprising result--that information capacity depends on surface area—has (e) a natural explanation if the holographic principle (proposed in 1993 by Nobelist Gerard't Hooft of the University of Utrecht in the Netherlands and elaborated by Susskind) is true**.** In the everyday world, a hologram is a special kind of photograph that generates a full three-dimensional image when it is illuminated in the right manner. When it com,es to structures,one cannot bypass Deleuze and his work. Levi Strauss Has Also Noticed That Signs Always Offer An Excess. The System Of Language, 'The Order Of The Known' Exceeds Actual Speech, Even Attempts At Totalization (48). Laws Pre-Exist Actual Cases. [So We Were Getting Close To A Role For Social Life, But Then It Gets Metaphysical Again]. As LS Put It, The Universe Signified Long Before Human Beings Knew What It Was Signifying. By Contrast, The Domination Of Nature Proceeds Partially And Progressively, Step By Step Unlike Social Life Where All Its Goals And Possibilities Given At Once. We're Back With Two Series, This Time Conceived As Rhythms, Social And Natural. Both Technocrats And Dictators Attempt A False Synthesis Of These Two Rhythms. Levi Strauss Referred To 'The Floating Signifier' As A Creative Force And Deleuze Wants To Say It's 'The Promise Of All Revolutions' (49). There Are Also 'Floated Signifieds', Which Seem To Be Possibilities Which Have Not Yet Been Realized. These Can Fill The Gap Between Signifier And Signified [And Are Found In Common Sense Expressions Like 'Gadgets' Or 'Whatnot' – Maybe Connected To The Idea Of A Bricoleur?]. It Implies A Symbolic Content, But Does Not Attempt To Fill It With Specifics. Together, These Possibilities Constitute A Structure, Two Heterogeneous Series, One Signifying, One Signified, Interdependent, And Including Particular Events, Singularities, Emitted By A Differentiator. The Singularities Belong To Neither Series Exclusively And Thus Have No Coherent Identity –Each Is An Excess In One Series And A Lack In The Other. The Singularities Can React Back On The Series, So Structures And Events Are Interdependent [So Structures Need A Dynamic Element, And, D Argues, An Excess, An Empty Square Instead Of Total Systematic Closure. Addresses The Old Issue Of The Static Nature Of Structuralism]. The Signifying Series Contains A Series Of Ideal Events, An Internal History. Differentiators Articulate Series And This Produces A 'Tangled Tale' Overall (51). **Sense Can Be**

Found In Either Series. It Is Not Just Signification But The Relation That Produces Signifier And Signified, [The Operation Of The Whole Structure In This Expanded Sense]. Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules.All the information describing the 3-D scene is encoded into the pattern of light and dark areas on the two-dimensional piece of film, ready to be regenerated. The holographic principle contends that an analogue of this visual magic applies to the full physical description of any system occupying a 3-D region It proposes that another physical theory defined only on the 2-D boundary of the region completely describes the 3-D physics. If a 3-D system can be fully described by a physical theory operating solely on its 2-D boundary, one would expect the information content of the system not to exceed that of the description on the boundary. Can we apply the holographic principle to the universe at large? The real universe is a 4-D system It has volume and extends in time. If the physics of our universe is holographic, there would be an alternative set of physical laws, operating on a 3-D boundary of spacetime somewhere, which would be equivalent to our known 4-D physics. We do not yet know of any such 3-D theory that works in that way. Indeed, what surface should we use as the boundary of the universe? One step toward realizing these ideas is to study models that are simpler than our real universe. A class of concrete examples of the holographic principle at work involves so-called anti-de Sitter spacetimes **.** The original de Sitter spacetime is a model universe first obtained by Dutch astronomer Willem de Sitter in 1917 as a solution of Einstein's equations, including the repulsive force known as the cosmological constant. De Sitter's spacetime is empty, expands at an accelerating rate and is very highly symmetrical. In 1997 astronomers studying distant supernova explosions concluded that our universe now expands in an accelerated fashion and will probably become increasingly like a de Sitter spacetime in the future. Now, if the repulsion in Einstein's equations is changed to attraction, de Sitter's solution turns into the anti-de Sitter spacetime, which has equally as much symmetry. More important for the holographic concept, it possesses a boundary, which is located "at infinity" and is a lot like our everyday spacetime. Using anti-de Sitter spacetime, theorists have devised a concrete example of the holographic principle at work: a universe described by superstring theory functioning in an anti-de Sitter spacetime is completely equivalent to a quantum field theory operating on the boundary of that spacetime Thus, the full majesty of superstring theory in an anti-de Sitter universe is painted on the boundary of the universe. Juan Maldacena, then at Harvard University, first conjectured such a relation in 1997 for the 5-D anti-de Sitter case, and it was later confirmed for many situations by Edward Witten of the Institute for Advanced Study in Princeton, N.J., and Steven S. Gubser, Igor R. Klebanov and Alexander M. Polyakov of Princeton University. Examples of this holographic correspondence are now known for spacetimes with a variety of dimensions. This result means that two ostensibly very different theories--not even acting in spaces of the same dimension--are equivalent. Creatures living in one of these universes would be incapable of determining if they inhabited a 5-D universe described by string theory or a 4-D one described by a quantum field theory of point particles. (Of course, the structures of their brains might give them an overwhelming "commonsense" prejudice in favor of one description or another **Holographic Space-Time (Crystal Links, Tom Hanks and Wikipedia Francisco Di Biase** propose a quantum-informational holographic model of brain-consciousness-universe interactions based in the holonomic neural networks of Karl Pribram, in the holographic quantum theory developed by David Bohm, and in the non-locality property of the quantum field described by Hiroomi Umezawa. He considers this model an extension of the interactive dualism of Sir John Eccles, of an interconnection between brain and spirit by means of quantum microsites named dendrons and psychons. **Francisco Di Biase** proposes a dynamic concept of consciousness seen as a holoinformational flux interconnecting the holonomic informational quantum brain dynamics, with the quantum informational holographic nature of the universe. This self-organizing flux is generated by the holographic mode of treatment of neuronal information and can be optimized through practices of deep meditation, prayer, and others states of higher consciousness that underlie the coherence of cerebral waves. In brain mapping studies performed during the occurrence of these harmonic states we can see the spectral array of brain waves highly synchronized and perfectly ordered like a unique harmonic wave, as if all frequencies of all neurons from all cerebral centers played the same symphony. This highly coherent brain state generates the non-local holographic informational cortical field of consciousness that interconnect the human brain and the holographic cosmos. The comprehension of this holonomic quantum informational nature of brain-consciousness-universe interconnectedness allows us to solve the old mind-matter Cartesian hard problem, unifying science, philosophy, and spiritual traditions in a more transdisciplinary, holistic, integrated paradigm. In this new arrangement cosmovision, consciousness and transpersonal phenomena becomes part of Science and of the very holoinformational nature of the Holographic Conscious Multiverse. **DOI: 10.14704/nq.2009.7.4.259 Quantum-Holographic Informational Consciousness Francisco Di Biase NeuroQuantology** Holography suggests a considerable reduction of degrees of freedom in theories with gravity. However it seems to be difficult to understand how holography could be realized in a closed re-contracting universe. In this Letter we claim that a scenario which achieves that goal will eliminate all spatial degrees of freedom. This would require a different concept of quantum mechanics and would imply an intriguing increase of power for the natural laws. **Physics Letters B Volume 451, Issues 1–2, 1 April 1999, Pages 19–26 Richard Dawid doi:10.1016/S0370-2693(99)00205-1Vijay Balasubramanian, Per Kraus, Albion Lawrence, and Sandip P. Trivedi** describe probes of anti–de Sitter spacetimes in terms of conformal field theories on the AdS boundary. Basic tool is a formula that relates bulk and boundary states—classical bulk field configurations are dual to expectation values of operators on the boundary. At the quantum level they relate the operator expansions of bulk and boundary fields. Using our methods, we discuss the CFT description of local bulk probes including normalizable wave packets, fundamental and D-strings, and D-instantons. Radial motions of probes in the bulk spacetime are related to motions in scale on the boundary, demonstrating a scale-radius duality. They also discuss the implications of these results for the holographic description of black hole horizons in the boundary field theory.DOI: http://dx.doi.org/10.1103/PhysRevD.59.104021 **Holographic probes of anti–de Sitter spacetimes Phys. Rev. D 59, 104021 – Published 26 April 1999 Vijay Balasubramanian, Per Kraus, Albion Lawrence, and Sandip P. Trivedi** The existence of a fundamental scale, a lower bound to any output of a position measurement, seems to be a model-independent feature of quantum gravity. In fact, different approaches to this theory lead to this result. The key ingredients for the appearance of this minimum length are quantum mechanics, special relativity and general relativity. As a consequence, classical notions such as causality or distance between events cannot be expected to be applicable at this scale. They must be replaced by some other, yet unknown, structure. **LUIS J. GARAY, Int. J. Mod. Phys A, 10, 145 (1995) DOI: 10.1142/S0217751X95000085 QUANTUM GRAVITY AND MINIMUM LENGTH** A digital computer is generally believed to be an efficient universal computing device; that is, it is believed able to simulate any physical computing device with an increase in computation time by at most a polynomial factor. This may not be true when quantum mechanics is taken into consideration. This paper considers factoring integers and finding discrete logarithms, two problems which are generally thought to be hard on a classical computer and which have been used as the basis of several proposed cryptosystems. Efficient randomized algorithms are given for these two problems on a hypothetical quantum computer. These algorithms take a number of steps polynomial in the input size, e.g., the number of digits of the integer to be factored. Copyright © 1997 Society for Industrial and Applied Mathematics **SIAM J. Comput., 26(5), 1484–1509. (26 pages) Polynomial-Time Algorithms for Prime Factorization and Discrete Logarithms on a Quantum Computer ISSN (print): 0097-5397 ISSN (online): 1095-7111 Publisher: Society for Industrial and Applied Mathematics Peter W. Shor DOI: 10.1137/S0097539795293172** The classical dynamics of M-dimensional extended objects arising from stationary points of the world volume swept out in space time is discussed from various points of view. A introduction to the Hamiltonian mechanics of bosonic compact M (em) branes is given, emphasing the diversity of the different formulations and gauge choices. For moving hypersurfaces, a graph description—including its nonlinear realization of Lorentz invariance—and hydrodynamic formulations (in light-cone coordinates as well as when choosing the time coordinate of a Lorentz observer as the dependent variable) are presented. A matrix regularization for $M = 2$ (existing for all topologies) is explained in detail for the 2-sphere, as well as multilinear formulations for $M > 2$. The recently found dynamical symmetry that exists for all M and related reconstruction algebras are covered, just as some explicit solutions of the level-set equations. **Jens Hoppe 2013 J. Phys A: Math. Theor. 46 023001 doi:10.1088/1751-8113/46/2/023001**

Relativistic membranes N Bodendorfer et al rederive the results of our companion paper, for matching space–time and internal signature, by applying in detail the Dirac algorithm to the Palatini action. While the constraint set of the Palatini action contains second class constraints, by an appeal to the method of gauge unfixing, we map the second class system to an equivalent first class system which turns out to be identical to the first class constraint system obtained via the extension of the ADM phase space performed in our companion paper. Central to analysis is again the appropriate treatment of the simplicity constraint. Remarkably, the simplicity constraint invariant extension of the Hamiltonian constraint, that is a necessary step in the gauge unfixing procedure, involves a correction term which is precisely the one found in the companion paper and which makes sure that the Hamiltonian constraint derived from the Palatini Lagrangian coincides with the ADM Hamiltonian constraint when Gauß and simplicity constraints are satisfied. **N Bodendorfer et al** therefore have rederived new connection formulation of general relativity from an independent starting point, thus confirming the consistency of this framework. **N Bodendorfer et al 2013 Class. Quantum Grav 30 045002 doi:10.1088/0264-9381/30/4/045002 new variables for classical and quantum gravity in all dimensions: II. Lagrangian analysis** As K§emaraja points out, none of the practices taught in the Stanzas on Vibration belong to the Individual Means and so it does not, (e) strictly speaking, concern Spanda doctrine, if that is, we consider the Stanzas to be the basic text of the Spanda school. From K§emaraja's point of view, however, the third section of the Aphorisms of Siva (Sivasutra), which is both the last and most extensive, is (=) largely an exposition of this category of practice. The Stanzas and Aphorisms have been traditionally linked together (e&eb) and so, even though we feel that they should be distinguished sofar as the Stanzas rather than the Aphorisms teach the Doctrine of vibration as such, we are nonetheless justified in referring to the Aphorisms as (=) its major source. Our exposition of the Individual Means will therefore be largely based on (e) Ksemaraja’s interpretation of (e) the third section of Aphorisms and we will present it, as he does, as an exposition of a possible mystical journey of individualised (anava) consciousness to realisation. We follow K§emaraja because he understood the practise taught in the Aphorisms in these terms, thereby not only illustrating for us how it fits into this scheme but also how he understood the basic categories of practice and their relationship to one another. According to K§emaraja, the first Aphorism of each section of the Sivasutra characterises the condition and nature of the Self at the corresponding three levels of practice. In other words, they indicate the yogi’s basic state at each level in terms of his self-identification. This identification corresponds to his existential condition as a degree of self- realisation in the process leading to the authentic self-awareness of the liberated. The very first Aphorism starts directly with this, the highest state, by declaring that the Self is pure, dynamic and universal consciousness (caitanya).This is true for the yogi who has awakened to his authentic nature at the Divine (sambhava) level of being. At the Individual (anava) level, however, the situation has changed. In this sphere of consciousness the intermediate processes of discernment, analysis and classification of perceptions, which bridge the gap in the flow of awareness from the universal subject to a specific object of knowledge, appear to take over the status of the perceiving subjectivity which underlies them. The universal Self recedes into the background as a pure, undefinable awareness, and the individual ego, consisting of the perceptions, thoughts and emotions generated by the contact between the universal perceiver and the perceived, emerges in the juncture between them. Thus at this level, as the Aphorisms say, the Self is the mind. This is the Self which moves (atati) from one state of being to another, from one body to the next carrying with it subtle traces left behind by its sensory and mental activity. Together these are said to constitute, and be caused by, the subtle body technically called the 'City of Eight' (puryasfaka) with which consciousness is identified and due to which it is subject to the constant alterations of pleasure, pain and inertia. The Stanzas teach: [The soul] is bound by the City of Eight (puryaffaka) that resides in the mind, intellect and ego and consists of the arising of the [five] subtle elements [of sensory perception]. He helplessly suffers worldly pleasure and pain (bhoga) which consists of the arising of mental representations born of that [City of Eight] and so its existence subjects him to transmigration. **Whereas consciousness itself is (=) the subject who practises the Divine Means (Sambhavopayd), the subject who practises the Individual Means is (=) the mind. Unlike the Empowered Means, however, the mind is not (e) directed inwards onto (e&eb) itself. At the Empowered level, enlivened by (e) the direct intuition (pratibha) consciousness has (e) of its own nature, mind ceases to (e) function merely in the paradigmatic, formative manner which gives rise to (eb) mental representations, but**

operates instead as (=) the subtle introverted activity of (e) reflective awareness (vimarsa), the power of consciousness (sakti). This activity, as we have seen, is the essence of Mantra which, independent of the senses, is no longer restricted (e&eb) in any way. At the Individual lew, however, the creative powers of consciousness reflected through the eAtroverted mind are greatly attenuated. All that remains is the power to form thought-constructs and make determined resolutions (sankalpa) which go on to issue through the body into outer action to make the private creations of the mind apparent to others. The Individual Means, therefore, deals with the objectively perceived contents of consciousness and hence with the individual subject as a composite aggregate of objective elements, ranging from the subtle life force (prdrta) to the physical body and its outer environment. The practices belonging to this Means are thus of two types. One is concerned with the individual subject who resides in, and as, the psycho-physical organism; the other with external reality. What this implies essentially is that practice at this level is not concerned as much with the will or cognitive consciousness **(refer Hiedigger who proposes the same philosophy: italics mine**) as are the other two Means, but with the power of action applied, in the context of the practice taught in the Aphorisms, to (e&eb) the spiritual activity of Yoga. According to Ksemaraja, the Individual Means culminates in (eb) the Empowered state and hence leads to (eb) the levels of practice beyond it. 251 This is possible because (e) despite their differences, there is (=) an essential similarity between them. The aim of both the Individual and Empowered Means is (=) to purify the discursive representa- tions of (e) differentiated perceptions (vikalpasamskara) 252 and so lead (eb) the yogi to the expanded (yikasita) consciousness of (e) the Divine (sambhava) state. The other levels of practice therefore both sustain and complement (eb&eb+) it. The activity of individual consciousness can be fully perfected only when it operates through the flow of the conative and cognitive powers which together constitute the pure activity of universal consciousness beyond all means (anupaya). In fact, according to Ksemaraja, all three soteriological types function together in various ways, their corresponding states representing dimensions of the same experience. For example, the upsurge of consciousness (udyama) which is the supreme, **illuminating intuition (parapralibha)** of the Divine state (sambhavavastha) is concomitant with the gathering together of all the powers of consciousness in the Empowered state. The Divine Means, in other words, leads to the experience of Power (sakti) which in its turn, when fully affirmed, marks the attainment of a permanent contemplative consciousness (turiyatita) at the Divine level which persists unaltered in every state of consciousness. Consequently, Ksemaraja concludes his exposition of the first section of the Aphorisms which exemplifies, according to him, the Divine Means, by saying: Thus we have explained the first expansion which starts with [the Aphorism] 'the Self is pure dynamic consciousness' **(note this happens in evolutionary pocess and in normal human being it remains as witness consciousness italics mine)** and expounds the nature of the realisation (prathana) attained through the Divine Means. It is the intuitive insight (samapatti) of Bhairava's nature which is, as we have said, the upsurge of consciousness that quells all bondage, namely, the ignorance of that freedom which makes it manifest. Transforming all things into the nectar of one's own innate bliss, it bestows every yogic accomplishment (siddhi) including mystic absorption in the vitality of Mantra, the highest of them all. Accordingly, we have, in the course of this exposition, explained the nature of Sakti in order to show that the Divine nature (Sambhavarupa) possesses [every] power. Another way in which the Means are related to (e&eb) one another is illustrated by the recurrence of the same Aphorism in different sections of the Sivasutra which indicates, according to Ksemaraja, that the same practice belongs to (e) more than one Means. Both times this happens, the Aphorism appears first in the section dealing with (e&eb) the Divine Means and then recurs in that concerned with (e&eb) the Individual Means. In one case, Ksemaraja tells us this is because practice at the Divine level requires no effort whereas at the Individual level, the yogi must exert himself to achieve the same state that at the Divine level dawns spontaneously. At the Empowered level also, as the Sivasutra says, 'effort achieves the goal'. Here, however, because as the Empowered Means is, according to Ksemaraja, predominantly concerned with the contemplation (anusamdhi) of the vitality of Mantra, the effort exerted is that required to bring the practice of Mantra to fulfillment. It is, as Ksemaraja says, 'the spontaneous effort exerted to grasp the initial expansion of intention to apply oneself to the contemplation [of Mantra]. It is this exertion which wins the favour of the gods of Mantra and identifies the adept with them.' The second case of the same practice being taught in different sections of the Aphorisms concerns the realisation of the Fourth State of contemplative consciousness (turiya) in the other three states of waking, dreaming and deep sleep. At the Divine level this takes place by **'violently digesting' (hafhapaka)** the three states in the Fourth. At the Individual level the Fourth state is first experienced at the junctures between the other three states and then induced gradually to spread out from these Centres to pervade the other states like oil extending slowly through a piece of cloth. The difference in this case between the levels of practice is not only that at the Divine level it reaches fulfillment spontaneously, but it is also sudden and complete, leading directly to the liberated state of consciousness Beyond the Fourth (turiyatita) At the Individual level, however, practice is gradual and even when the yogi manages to rise to states of contemplation, he must take care not to fall to lower levels of consciousness. Indeed, until the yogi attains the sudden and direct realisation of perfect enlightenment, whatever be his state of consciousness or level of practice, he is bound to rise and fall because his contemplative state is necessarily transitory (kadacitka) however long it may last. The yogi is more prone to these ups and downs the lower his basic state of consciousness. Consequently, the last section of the Sivasutra repeatedly instructs the yogi not only how to rise to higher levels of consciousness and maintain them, but also in what way he is liable to fall from them and how to regain them. Ksemaraja stresses that the rise from one level of consciousness to another is marked by the transition from a lower Means to a higher. Conversely, a fall from the higher level to the lower entails practice of a lower Means. The measure of the yogi's level of consciousness and that which sustains him in it allowing him to progress further, is his attentiveness (avadhana) to the higher realities he experiences in the more elevated states. Thus the last Aphorism of the second section of the Sivasutra warns the yogi that if his pure awareness (suddhavidya) of his oneness with all things slackens, he will fall from his awakened state to dream the dream of thought-constructs. From Ksemaraja's point of view this means that the negligent yogi must now resort to the Individual Means described in the next section to return to his former, higher Empowered practice in which he experiences this oneness. Ksemaraja expounds practice at the Individual level, as he sees it in the Aphorisms, as extending from one Means to the next. For example, practice at the Individual level diverts the flow of the vital breath (prana) from its more usual course and induces it to enter the Central Channel (susumna) along which it rises as a pure conscious energy (technically called 'kuritfalini'). This leads the yogi to the Empowered state in which he enjoys the pure awareness of unity. If he manages to make it truly his own and it becomes his basic state of being, he enters the Divine plane (sambhavapadd) of identity with Siva. The Individual Means is both a point of departure to higher levels of practice and the level to which the yogi returns if he falls. Thus although the practices taught in the last section of the Aphorisms may belong to any one of the three Means, they are collectively treated as part of the Individual Means because they start from it and because it is the yogi's abiding standby if he falls. Let us turn now to the basic practice at the Individual level, as Ksemaraja understands it. This is essentially Yoga. According to the Classical Yoga system taught by Patanjali in the Aphorisms of Yoga (Yogasutra), Yoga is defined as 'the quelling of the fluctuations of the mind' (cittavrttinirodha). The aim is to sever the spiritual essence of the Person (purusa) from the defiling materiality of Nature (prakfti), even though the word 'Yoga' means to 'unite' or 'yoke together.' Here, however, Yoga combines both union and cessation. It is the act (kriya) of removing the latent traces (yasana) of differentiated perceptions (yikalpa) born of the impurities (mala) which contract consciousness **(like pravrutti and Nivrutti; italcis mine**). This is achieved by uniting all the elements of experience (tattva) together in the wholeness of the activity of consciousness. As Jayaratha explains: The [wise] consider Yoga to be the union of one thing with another/ thus, in accord with this dictum, Yoga is the [act] of uniting [all] the metaphysical principles together within consciousness . . . , Ksemaraja seeks initially to establish the best form of Yoga for the yogi to practice at the Individual level. His sources are two Tantras he knew well and considered to be amongst the most important, namely, The Tantra of (Siva's Third) Eye (Netratantra) and The Tantra of the Liberated Bhairava (Svacchandabhairavatantra). The basic model is that of the Eight-limbed Yoga (asfariga) taught by Patanjali which consists of: 1) The five restraints (yama\ namely, abstention from violence (ahirrisa), falsehood (satya), dishonesty (asteya), sexual intercourse (brahmacarya) and desire for more than the essential (aparigrahd) 2) The five disciplines (niyama), namely, cleanliness (sauca), contentment (santo$a), austerity (tapas\ study (svadhyaya) and reverence for God (Uvarapranidhand) 3) Posturing of the body (asana) in a manner conducive to the practice of meditation and physical health. 4) Regulation of the breath (pranayama) 5) Withdrawal of the senses from their objects (pratyahara) 6) Focusing of attention (dharana) 7) Meditation (dhyana), that is, steady, uninterrupted concentration. 8) Contemplation (samadhi). Ksemaraja **rejects** Patanjali's system because he believes it to be a form of Yoga that can, at best, lead only to limited yogic attainments (mitasiddhi). In the Netratantra, however, Siva teaches a different, higher form of the Eight Limbs of Yoga which lead to perfect penetration into the supreme, transcendental principle 280 of which the Netratantra says: Speech cannot express, nor the eye see, the ears hear, or the nose smell, the tongue taste, the skin touch or the mind conceive that which is eternal. Free of all colour and flavour, endowed with all colours and flavours, it is beyond the senses and cannot be objectively perceived. O goddess, those yogis who attain it become immortal gods! By great practice and supreme dispassion . . . one attains Siva, the supreme imperishable, eternal and unchanging reality. A necessary preliminary of all Tantric Yoga is a process technically called the 'purification of the elements' (bhutasuddhi), through which the body is homologized with the macrocosm and so made a fit vessel for the pure, conscious presence of the Deity within it. Ksemaraja equates this with the meditation (dhyana) which, according to the Mdlinivijayatantra, characterises the Individual Means. In order to practice this meditation the yogi must visualise the dissolving away of all the forces in the body. There are two ways in which this can be done. The first is called 'the contemplation of dissolution' (layabhdvana). Through it the progressive differentiation of consciousness from its causal, pre-cosmic form to its phenomenal manifestation is reversed As the Vijnanabhairava teaches: "One should meditate on the All in the form of the Paths of the world- orders etc. considered in their gross, subtle and supreme forms until, at the end, the mind dissolves away." Mediated by consciousness, the macrocosm rests in (eb) the microcosm which is emitted (eb) along with it successively in (eb) the emptiness of the individual subject, vital breaths, mind, psychic nerves (ndtfi), senses and external body. The yogi reproduces this process by visualising the totality of reality including the world-systems, metaphysical principles and cosmic forces along with the Mantras, letters and syllables which represent them, as arising successively throughout the psycho-physical body so as to constitute it. Deployed in this way they form the Cosmic Path along which the yogi ascends, absorbing as he does so, the lower elements into the higher, thus strengthening and extending his unifying awareness (anusamdhdnd) of the configuration of the Path. Thus, moving from the gross elements constituting the outer physical body, to pure sensations (tanmdtra), then to the senses and mind back to their primordial source, the yogi rises from the **embodied subjectivity** of the waking state to the Fourth State (turiya) of contemplation where he is one with the pervasive intent which initiates the creative vision of consciousness. Abhinava writes: Once [the yogi] has known [this] Path in its completeness, he must then dissolve it into the deities who sustain it and these successively into the body, breath, mind [and emptiness] as before, and all these into his own consciousness. Once this is full and an object of constant worship, it destroys, like the fire at the end of time, the ocean of transmigration.Thus, the second method Ksemaraja teaches to dissolve away the diversity of sensory, mental and physical energies into the unity of consciousness is a meditation on the Fire of Consciousness (dahacintd) which the yogi visualises as burning away all division. At the Divine level (sambhavopaya) the yogi witnesses the sudden and violent withdrawal of all objectivity into the pure ego (aharri), like the pouring of fuel into a raging fire. He does not need to visualise this process but merely attend to it with a passive, receptive attitude. At the Individual level the yogi must exert his imagination to induce this process and so rise to the Divine level through the Empowered. The Vijnanabhairava teaches: Visualise the fortress [of your body] burning with the Fire of Time (kalagni) risen from the Abode of Time; then at the end peace manifests. The Fire of Time {kalagni) resides underneath the hell worlds at the bottom of the Cosmic Egg (Brahman^a). It issues from Ananta — a form of Siva who presides over the lower regions. He floats on a boat in the causal waters supporting the Egg, his mind all the while fixed on Bhairava. The flames of the Fire of Time rise up to the hell-worlds heating them intensely and radiate its energy throughout the universe. At the end of each period of creation the flames rise higher and destroy the old cosmic order to make room for a new one. At the microcosmic level the yogi reproduces this process by mentally placing the letters of the alphabet, in the prescribed order, on the limbs of his body starting from the left toe to the top of the head. As his attention progresses upwards, he visualises the Fire of Time moving with it in such a way that his bodily consciousness, together with the universe of differentiated perceptions, is gradually burnt away leaving in its place the white ashes of the undivided light of consciousness. Ksemaraja considers this meditation (dhyana) to be a limb of a programme of yogic practice at the Individual level 291 of which the remaining limbs are as follows: Posture (A sana). The yogi fixes his attention on the centre between the inhaled and exhaled breath, absorbing in this way the flux of his awareness into the unfolding power of knowledge which rises initially as the upward flowing breath (udanaprana) in the Central Channel (su§umna) between the other two breaths. The Prank aspect of this flow disappears as it moves upward and the yogi experiences the spontaneous rise of the omniscience of consciousness within himself. The mind reverts back to its original, pervasive conscious nature and understands the infinite fact of Siva's omnipresence. This is the firm seat (asana) upon which the yogi sits to practice. Regulation of the Breath (Pranayama) .To regulate the movement of the breath, the yogi must first cleanse the right and left channels of the ascending and descending breath by blocking the left nostril while exhaling and the right while inhaling a few times. This ensures that the movement of the breath is firm and evenly distributed. Next, without attempting to control it in any way, he attends to the flow of his breathing. As the mind becomes steadier and in closer harmony with the rhythm of its movement, the duration of each inhalation and exhalation gradually alters until they become equal. At this stage they unite and merge in the upward flowing current of vitality in the Central Channel (Susumna). This is when true Pranayama begins. The yogi's mind pure and tranquil, he returns, as it were, to a prenatal state and the external breathing cycle is internalized, so that it no longer moves through the lungs but passes directly to the universal source of vitality. The yogi, now at the Empowered level of practice, experiences this movement as travelling from the Heart centre upwards to a point distant twelve fingers above the head where it merges in the void of consciousness. Free of its outer gross form, the breath moves freely through the Central Channel and soon transcends even this subtle movement to become one with the supreme vibration of consciousness. In this way, the yogi's breathing becomes one with the spontaneous rise and fall of energy from the bosom of the absolute. Abhinava quotes the Tantra of the Line of Heroes (Viravalitantra) as saying: When, by constantly merging the mind in Siva, Who is the pure conscious nature, the Sun and Moon [of the two breaths] have dissolved away and the Sun of Life, which is one's own consciousness, has reached the twelve-finger space, this is termed liberation. Breath control [at this stage] serves no useful purpose. Breath control which merely inflicts pain on the body is not to be practised. He who knows this secret is both themselves liberated and liberates others. **Focusing of Attention (Dhara nA):** Attention is fixed on the psychic centres in (eb) the body corresponding to (e&eb) the five gross elements In this way the vital breath is successively directed to (e) these centres from (e) the Heart of consciousness to refresh and stimulate their activity. First it moves to the Earth centre in the throat which regulates (e&eb) the firmness of (e) the bones and flesh of the body; then to the Water centre in (eb) the glottis responsible for (e) the balance of (e) the bodily fluids. After this it travels to (e&eb) the navel which is the Fire centre dealing with (e&eb) digestion and anabolisms and catabolisms in general. It then moves to the Wind centre in the toe of the left foot which governs the movement of gases to and from the cells via the circulatory system. When the yogi has thus achieved control over these forces, the breath rises from the Heart to the top of the head and he becomes master of the Ether element and so attains every yogic power. **Meditation (Dhyana)** The highest form of meditation stills the flux of the qualities (guna) and induces the mind into a state of contemplative absorption. The object of this meditation is the supreme and pervasive divinity of the pure subject whose true nature is known to none but himself alone (svasatpvedya). The yogi attains him by merging into the constant flow of awareness that streams into the Light which illumines his own nature. Contemplation (Samadhi) .The yogi rises to the level of contemplation when the awareness he has of himself and the things around him become one and he realises his own identity with Siva, **(or Rama the omniscient: cosmic general ledger)** the sole reality. The aim of this Yoga in all its phases is to achieve the Fourth State of consciousness (turiya) beyond the three states of waking, dreaming and deep sleep and to then ultimately reach the liberated state Beyond the Fourth (turiyatita). These five states correspond to: (a) Siva's activity (vy apara), that is, His power of action; (b) Siva's Lordship (adhipatya), which is His power of knowledge; (c) the absence of these two, which corresponds to Siva's power of will; (d) His exertion (prerakatva), which contains all the cycles of creation and destruction and, (e) the rest Siva enjoys in His own nature, which is His power of consciousness. The first three states, when divorced from the last two, belong to the sphere of transmigratory existence. The Fourth and Beyond the Fourth on the other hand are higher, supramundane (alaukika) states of consciousness in which the yogi enjoys bliss and repose (visranti) in (e&eb) his own nature by penetrating (samavesa) into (e&eb) the universal consciousness of the Self, through which he ultimately becomes liberated (jivanmukta). Beyond the Fourth is the state of awareness ParamaSiva Himself enjoys when duality has entirely disappeared and everything is realised to be one with consciousness. The Fourth is the state of awareness of the yogi who, catching hold of the pure subjectivity (upalabdhrta) flowing through the lower three states, is still actively eliminating his sense of duality. While the former is the supreme subject as (=) T consciousness (aham), the latter is (=) the pure awareness (prama) or I-nesses (ahanta) of (e) the subject which encompasses the lower states, giving them (e&eb) life and uniting (e&eb) them together As such, the Fourth State is the reflective awareness of one's own nature shining in all three states at one with (e&eb) them. The fact that we recall that we slept well is proof that this state of consciousness persists (eb,eb+) even in deep sleep. Indeed, if the flow of Turiya could somehow be brought to a halt, all the other states of consciousness would come to an end in the absence of the pure subjectivity which makes them, and their contents, manifest. The states of waking, dreaming and deep sleep correspond to the form of awareness consciousness assumes (eb) when it predominantly manifest as the object, means of knowledge and individual subject, respectively. Turiya is the pure awareness (prama) that both transcends them and merges them (e&eb)all into itself. 300 As such, it appears as the triad of deed, means and agent in the pure act (vy apara) of consciousness unsullied by any outer reality. Abhinava explains: {Turiya) transcends the three aspects of *form\ 'sight' and T consisting as it does of the pure act of 'seeing'; therefore any means [by which this state could be realised] has merely a [provisional] instrumental value. It is, in other words, pure subjectivity of the nature of absolute freedom, independent of all external means. This is the state of consciousness called Turiya, luminous with its own light. Turiya is thus not just a psychological state but the supreme creative power (para sakti) of consciousness, the Goddess (samviddevi) who generates and withdraws the entire universe of subject, object and means of knowledge. In the Heart of Recognition Ksemaraja explains: Whenever the extroverted [conscious] nature rests within itself, external objectivity is withdrawn [and consciousness] is established in the inner abode of peace which threads through the flux of awareness in every [externally] emanated [state]. Thus Turiya, the Goddess of Consciousness, is the union of creation, persistence and destruction. **(Read as cosmic consciousness; Kshemaraja does not distinguish like we have done, individual, collective and cosmic and of three states)** She emanates every individual [cycle] of creation and withdraws it. Eternally full [of all things] and [yet] void [of diversity] She is both and yet neither, shining radiantly as non-successive [consciousness] alone. The yogi is fully absorbed in this state of consciousness and takes possession of its power when he is able to rise from contemplation (samadhi) carrying with him the abiding awareness of Turiya throughout his waking, dreaming and deep sleep. When he achieves this constantly, he continues to experience these states individually, but they no longer obscure the insight (pratibha) he has acquired because he realises that they are all aspects of the bliss of Turiya. Thus, while the common man calls this state the 'Fourth' (turiya) because he cannot experience it directly and knows only that it is beyond the other three, the yogi calls it 'Beyond Form' (rupatita) because (e) it transcends the detachment of the state of deep sleep which, devoid of objective content, is the naked form' of the individual subject tending towards the fullness of consciousness. Those who are on the path of knowledge (jnaniri) call it the 'Whole* (pracaya) because, in this state, they see the entire universe gathered together in one place. 'Supra-mental Awareness' (manonmana) is the name given to the experience of Turiya in the waking state. The yogi in this state moves and lives in the world of waking experience free of all disturbing thoughts while abiding in the transcendental silence beyond the activities of the mind. 'Infinite' is the name of the experience of Turiya while dreaming because, free of the limitations imposed upon the body by time and space, the yogi enjoys the unlimited expanse of the Self. When Turiya is experienced in deep sleep, the yogi's state is called 'All things' (sarvdrtha) because in it he discovers his freedom from limitations in this, the most contracted state of human consciousness. The yogi who manages to maintain Turiya- consciousness comes to experience the three states of waking, dreaming and deep sleep as the constant flow of the bliss of consciousness in which all traces of the relative distinction between these states and their contents is eradicated. Following the stream of Turiya to its highest level (para katfha), he reaches the state Beyond the Fourth (turiydtita), which is the universal consciousness (caitanya) of the Self. Here the yogi comes to rest within his own nature. Plunged in the vast, waveless ocean of the consciousness and bliss (ciddnanda) of the state Beyond the Fourth, the yogi becomes Siva, the Free One (svacchanda), and thus wanders freely, practising the Yoga of Freedom. K§emaraja equates the Fourth State with the pure (suddha), innate (sahaja) knowledge that one's own conscious nature is all things. It is the Supra-mental State (unmana) in which Siva's pervasive presence is experienced once the

Yoga practised at the Individual level attains fruition at the Empowered. What the yogi must do, once consciousness is elevated to grasp the Fourth State, is make it constant. He must forcefully lay hold of it within himself and not release his grip until it becomes permanent. Then he travels 'Beyond the Fourth' to enlighten- ment. Before this ultimate attainment the yogi inevitably falls. The forces operating within consciousness that limit and obscure it throw him down whenever they possibly can. The only way the yogi can defend himself against them is to maintain a constant attentive awareness of the Fourth State. He falls when he is distracted but when he attends carefully to his pure conscious nature, he realises that every aspect of his state of being, including the forces that lead him astray, are one with the pulsing flux of his own consciousness and so cannot affect him. These powers, which are the energies of Matrka we have already discussed, are not the only obstacles the yogi must overcome. He must, for example, also resist the temptation to rest content with the miraculous yogic powers (siddhi) he acquires in the course of his spiritual develop- ment. Again to do this he must practice Yoga. Similarly, in order to pervade the Fourth State gradually through the other states in the manner proper to practice at the Individual level, the method is the same. He must practise the higher yoga of the Tantras which, turning his mind inwards and freeing it from discursive representations, allows him to penetrate into the Supreme Principle. Once the yogi has attained this contemplative state, his main problem is to make it permanent. In the introvered state the gross external movement of the breath is suspended and with it the activity of the intellect, mind, individualised consciousness, powers of the senses and the ego. 313 When the yogi rises out of this state, he is liable to fall again into the lower order of creation generated by Maya if he does not maintain his awareness of the higher reality he has experienced and allows his awakened, illumined insight to be obscured by the dream-like vision of thought-constructs. 314 Naturally, the yogi must rise out of the introverted condition of suspension. It is inherent in the very nature of reality that it should move out of itself. 315 Pure, universal consciousness initially transforms itself into the vital breath 316 charged with the impression iyasana) of the power of awareness attained through introversion. By attending to the pulse (spanda) of the breath as it moves out of the absolute, the yogi can develop an intuitive sense of the inherent unity of all he will perceive in the mental and physical spheres created by the outpouring of consciousness. In this way he realises that his own nature is everywhere present in all he perceives and that all things thus reside within him. Blessed with this insight his consciousness remains free and unlimited even at the individual level where the breath, mind, senses and body are active. If the yogi fails to do this, he finds himself once again beset by the strictures of his embodied existence and must, as before, try to pervade all his other states of consciousness with the aesthetic delight (rasa) and wonder (camatkara) of the Fourth State he experienced in contemplation. Again this means that he must strengthen his pure, empowered awareness that his universal nature manifests as all things. In this way he discovers Siva's presence in every sphere of individualised consciousness ranging from the breath to outer objectivity. The yogi's mind then becomes tranquil and undistracted because wherever it may wander, the yogi perceives only Siva, his authentic nature. Consciousness is thus freed of all external referents and the yogi's subjectivity is purified of all identification with the body or anything else that belongs to the objective sphere. The yogi then becomes detached from the opposites of pleasure and pain and is transcendentally free (kevalin). The yogi is again, however, liable to fall if he allows himself to get entangled in the play of opposites. This fall is more serious than the others because, although he is caught by the confining restrictions of individual- ised consciousness as before, he is now also affected by karma. Fleeing from pain in the pursuit of pleasure he is bound to act (karma) to minimise one and maximise the (a **maximaization problem is mentioned elsewhere about the svabhava of human beings to enhance pleasure reduce deprivation)** other and so is thrown down to the lowest level of embodied subjectivity (sakala). In order to regain his lost state, he must ascend gradually, by Siva's grace, from one order of subjectivity to the next and so free himself progressively of the limitations of the lower levels to gain the greater freedom and expansion of the higher. As he progresses, the objective sphere also evolves from the grossest perceptions of physical objects outside the lowest order to subjectivity, through to the subtler inner, mental perceptions to finally reach the order of subjectivity that contains objectivity within itself and is free to externalise it at will. The degree to which this process develops depends, as before, on the yogi's awareness of the Fourth State. In consonance with the general principle that the remedy should suit the defect, the yogi is instructed to seek this higher state of consciousness in the wonder (camatkara) or delight (ananda) he feels in moments of intense physical pleasure. At first he experiences this subtle consciousness for an instant in the subjective sphere. If he manages to catch hold of it, it becomes more intense as the cognitive and objective spheres are also gradually pervaded and vitalised by it. Occasions for this practice are, for example, the sense of satisfaction one feels after a good meal or the aesthetic delight one experiences when listening to good music or the pleasure of sexual union with the Tantric consort or even solitary sexual excitation. In these moments of delight the yogi can penetrate momentarily into his own authentic Siva-nature (sambhavavesa) through the empowered contact (saktasparsa) m he makes with it in the freedom of the pure subjectivity of the Fourth State. If the yogi develops his awareness of this higher level of consciousness and maintains it, he eventually experiences it constantly. Clearly, what prevents the yogi from attending to his state of consciousness rather than the circumstances which induce it is the craving for pleasure (abhila§a) born of ignorance — the source of every impurity which clouds consciousness. Craving directs the yogi's attention towards outer, worldly things and so he is caught in the **net of thought- constructs**. To free himself of his worldly desires and reverse this binding extroversion, the yogi must eradicate its cause. To be freed of all the ups and downs of the path and no longer be tormented by the possibility of a fall, the yogi must see reality perfectly and completely. This insight is itself liberation and the moment it dawns the yogi is instantly freed. This sudden realisation is the goal of Tantric Yoga. Accordingly the Tantra declares: "He, who perceives reality directly, even for the brief moment it takes to blink, is liberated that very instant and never reborn again." Although the yogi's body and mind continue to function as before, they are like mere outer coverings which contain, but do not obscure, the mighty, universal consciousness which operates through them. The yogi's body is the universe, the senses the energies that vitalise it, his mind Mantra, the rhythm of his breath the pulse of time and his inner nature pure, dynamic consciousness. Raised above all practice, and hence all possibility of falling to lower levels, the yogi realises that he has always been free and that his journey through the dark land of Maya was nothing but a dream, a construct of his own imagination. **(Models are given in one of the papers of the series due to spatial constraints) Relationship betwixt string theory (note the spade remarks above) and holographic principle has been enucleated and expatiated in literature**. Some exemplar work is sententiously mentioned in the following:The ratio of shear viscosity to volume density of entropy can be used to characterize how close a given fluid is to being perfect. Using string theory methods, we show that this ratio is equal to a universal value of ℏ/4πkB for a large class of strongly interacting quantum field theories whose dual description involves black holes in anti–de Sitter space. **P K. Kovtun, D. T. Son, and A. O. Starinets** provide evidence that this value may serve as a lower bound for a wide class of systems, thus suggesting that black hole horizons are dual to the most ideal fluid **Viscosity in Strongly Interacting Quantum Field Theories from Black Hole Physics Phys. Rev. Lett. 94, 111601 – Published 22 March 2005 P K. Kovtun, D. T. Son, and A. O. Starinets** According to't Hooft the combination of quantum mechanics and gravity requires the three-dimensional world to be an image of data that can be stored on a two-dimensional projection much like a holographic image. The two-dimensional description only requires one discrete degree of freedom per Planck area and yet it is rich enough to describe all three-dimensional phenomena. After outlining't Hooft's proposal we give a preliminary informal description of how it may be implemented. One finds a basic requirement that particles must grow in size as their momenta are increased far above the Planck scale. The consequences for high-energy particle collisions are described. The phenomenon of particle growth with momentum was previously discussed in the context of string theory and was related to information spreading near black hole horizons. The considerations of this paper indicate that the effect is much more rapid at all but the earliest times. In fact the rate of spreading is found to saturate the bound from causality. Perception is not reality. It needs some hidden variables to posit the reality. (see earlier models).We Make Sense Of Objects, Events Or State Of Affairs When We Pin Them Down And Describe Them, State Propositions About Them. We Can Then Develop These Propositions Into Logical Forms To Draw Conclusions, Make Predictions Or Whatever. The Trouble Is, Neither Object As We See Them, Nor Propositions As We Commonly Use Them, Are At All Simple. Objects As We Perceive Them, For Example, Clearly Have All Sorts Of Characteristics As Well That We Don't Perceive. They Have A History, And A Potential For The Future, For Example. The Worst Problem Is That Objects As We See Them Are Actually Mixtures Of Things, The Affects Of Complex Causes: They Are 'Overdetermined', To Use The Phrase Associated With Both Freud And Marx. Deleuze Actually Draws On Resources In Classical Philosophy

To Argue This, Especially The Work Of The Stoics, Who Saw Objects And Events As A 'Mixture Of Bodies', This Mixture Emanating From Somewhere In The Depths, Below Conscious Sense Making. Incidentally, This Reliance On The Stoics Also Makes Deleuze A Bit Stoical, In The Sense That He Thinks That These Mixed Bodies Are Part Of Some Unified Whole (He Was Going To Call This Being), And The Role Of Destiny Is Associated With The Whole. It Follows That Ethically And Conceptually, All Human Beings Can Do This Discover The Ways In Which Being Works. There's No Point Complaining About It Either. This Is the Basis of Badiou's Critique Of Deleuze. It Is Also The Basis Of Deleuze's Anti-Humanism: We Don't Understand Reality By Trying To Develop A Conscious Synthesis, Tracking Analogies Based On Some Notion Of A Shared Essence, Or Seeing God As An Ultimate Synthesiser For That Matter. Events And States Of Affairs Are Also More Complex Than They Look, And Deleuze Illustrates This Discussion With The Extraordinary Notion Of 'Compossibility' In Leibniz. Basically, The Idea Is That Singularities Can Produce Events In All Sorts Of Divergent Ways, All Of Them Equally Possible, And This Potential Is Shrunk If We Just Study The Actual Course Of Events. Objects Are More Complex Than They Look, With All Sorts Of Bits Of Their Being Unavailable To Us, But Language Is Equally Complex. Here, Deleuze Tries To Demonstrate This By Looking At People Who Use All Kinds Of Linguistic Anomalies Such As Paradoxes, Or, In The Case Of Lewis Carroll Especially, Portmanteau Words Or Esoteric Words. Although These Constructions Offend Logic, And Are Strictly Speaking Nonsense, They Still Make Sense. This Also Points To Some Powers Of Language That Are Not Immediately Available To Inspection. More Conventionally, We Know That The Use Of Particular Words Can Have Different Functions In Any Language System—They Can Denote, They Can Manifest Inner Thoughts, And They Can Signify (In The French Sense, That Is Indicate The Existence Of A Structured Language System Which Enables Us To Communicate With Each Other. Deleuze Proposes To Modify Classical Saussurian Semiotics By Adding A Moveable Element, An 'Empty Space' Or Floating Signifier'). Again Wordplay Can Deliberately Confuse These Different Functions, As When I Use The Term 'It' To Denote A Specific Object, Only To Refer To A Whole Process As 'It', To Express Myself By Saying Something About 'It' And So On (Actual Easy Examples Are Thin On The Ground In Deleuze!). Then There Is One Of Those (Many) Philosophical Diversions Into Various Types Of Explanation For The Extra Elements That Are Not Available To Actual Objects Or Speech Acts. Platonists Thought The Extra Bits Referred To Some Universal Form Or Idea, Other Philosophers Like Husserl Or Kant Suggest There Was Some Transcendental Realm Beyond The Immediate. Deleuze Offers Objections To Both For Those Approaches, And Suggests That The Real Is Actually Divided Into Virtual And Actual Levels (Delanda's Commentary Is Invaluable Here). The Objects And Words Of Our Immediate Perception Are Actualised Are Condensed Out From Much More Complex Objects And Events At The Virtual Level. In This Book, About The Only Candidate For These Complex Objects Is The Singularity, Which Actualizes Itself In Various Partial Ways. Deleuze Goes On To Develop This Idea By Saying That Singularities Themselves, And The Events And Objects They Actualize, Are Produced In A Random Or Arbitrary Fashion, The Chance Is At The Heart Of Actualisation. We Learn That The Virtual Also Has Its Own Sense Of Time, Which Is Not The Usual One Which Is Highly Limited By The Insistence On The Present Tense In Human Operations. It Is A Very Abstract Discussion, Which Finally Comes To An Example I Could Understand—The Emergence Of Language In Freud. As Infants Develop, Their Biological Urges Produce Certain Infantile Concepts Like Part Objects. These Are Classically Mixed, Deriving From Contradictory Drives In The Depths Of The Unconscious. The Sounds The Infant Makes Our Initially Just Bodily Emanations, But They Gradually Come To Take On The Form Of Linguistic Units, Like Phonemes. There Are Elements Of Adult Language Available Too, Of Course, But These Are Initially Unintelligible. Then A Process Described As The Phantasm Manages To Combine Various Infantile Concepts Together Into A'disjunctive Unity', A Mixture Of Heterogeneous Elements Which Deleuze Thinks Characterises Most Objects. A Kind Of Primitive Narrative Develops In The Phantasm, Partly Driven By Biological Drives, And Partly Driven By Emerging Linguistic Competencies (Such As The Oedipal Scene). The Key To This Is The Freudian Notion Of The Phallus, Which Both Refers To Biological Organs Like Penises, And To Linguistic And Cultural Functions To Do With Authority And Value. The Phallus Is The Ideal Ambiguous Object (Or Empty Object As Deleuze Insists On Calling It), Able To Zigzag Between Bodies And Language, And Thus Make Divergent Series 'Resonate'. The Phantasm Therefore Develops An Energy Of Its Own, Which Permits A Relative

Disengagement From Sexual Energy (Sublimation) And, In The Final Stages, The Proper Development Of Language In The Form Of Symbolisation. At Last We Have Language And Events Brought Together On The Surface, Which Is Of The Level Of Consciousness. If I Have Read The Appendices Correctly, This Phantasmic Form Is Then Generalised To Include All The Operations Of Making Sense As Describes Right At The Beginning. I Have Lots Of Reservations About This Whole Schema, In Fact, Ranging From The General Structure Of The Argument, Where Philosophical Issues Are Introduced As If They Were Necessary, Whereas Their Role Is Been Predetermined All Along (For Example, Deleuze Has Always Admired Stoics, And Here They Are As Offering The Best Account), Right Down To The Curious Insistence On The Phantasm As The Adult Form Of Making Sense—In My View, Dreams Are A Lot More Like A General Model Of Thinking, And They Include The More Sophisticated Linguistic Operations Of Metonymy (Condensation), And Metaphor (Displacement). Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules. Finally **Leonard Susskind** considers string theory as (=) a possible realization of't Hooft's idea. The light front lattice string model of Klebanov and Susskind is reviewed and its similarities with the holographic theory are demonstrated. The agreement between the two requires unproven but plausible assumptions about (e&eb) the nonperturbative behavior of string theory. Very similar ideas to those in this paper have long been held by Charles Thorn. © 1995 American Institute of Physics **The world as a hologram Leonard Susskind J. Math Phys. 36, 6377 (1995); http://dx.doi.org/10.1063/1.531249 Ofer Aharonya, , Steven S. Gubserb, , Juan Maldacenab, c, , Hirosi Oogurid, e, , Yaron Ozf,** review the holographic correspondence between field theories and string/M theory, focusing on the relation between compactifications of string/M theory on Anti-de Sitter spaces and conformal field theories. They review the background for this correspondence and discuss its motivations and the evidence for its correctness. They describe the main results that have been derived from the correspondence in the regime that the field theory is approximated by classical or semiclassical gravity. We focus on the case of the supersymmetric gauge theory in four dimensions, but discuss also field theories in other dimensions, conformal and non-conformal, with or without supersymmetry, and in particular the relation to QCD. We also discuss some implications for black hole physics. **Physics Reports Volume 323, Issues 3–4, January 2000, Pages 183–386 Large N field theories, string theory and gravity Ofer Aharonya, , Steven S. Gubserb, , Juan Maldacenab, c, , Hirosi Oogurid, e, , Yaron Ozf, , doi:10.1016/S0370-1573(99)00083-6 T. Banks, W. Fischler, S. H. Shenker, and L. Susskind** suggest and motivate a precise equivalence between uncompactified 11-dimensional M theory and the $N=\infty$ limit of the supersymmetric matrix quantum mechanics describing D0 branes. The evidence for the conjecture consists of several correspondences between the two theories. As a consequence of supersymmetry the simple matrix model is rich enough to describe the properties of the entire Fock space of massless well separated particles of the supergravity theory. In one particular kinematic situation the leading large distance interaction of these particles is exactly described by supergravity. The model appears to be a nonperturbative realization of the holographic principle. The membrane states required by M theory are contained as excitations of the matrix model. The membrane world volume is a noncommutative geometry embedded in a noncommutative spacetime. DOI: http://dx.doi.org/10.1103/PhysRevD.55.5112 **M theory as a matrix model: A conjecture Phys. Rev. D 55, 5112 – Published 15 April 1997 T. Banks, W. Fischler, S. H. Shenker, and L. Susskind** These TASI lectures review the Holographic principle. The first lecture describes the puzzle of black hole information loss that led to the idea of Black Hole Complementarity and subsequently to the Holographic Principle itself. The second lecture discusses the holographic entropy bound in general space-times. The final two lectures are devoted to the ADS/CFT duality as a special case of the principle. The presentation is self contained and emphasizes the physical principles. Very little technical knowledge of string theory or supergravity is assumed. Report number: SU-ITP 99-14, KUL-TF-2000/03 Cite as: arXiv: hep-th/0002044 **TASI lectures on the Holographic Principle Daniela Bigatti, Leonard Susskind** The notion of a space-time uncertainty principle in string theory is clarified and further developed. The motivation and the derivation of the principle are first reviewed in a reasonably self-contained way. It is then shown that the nonperturbative (Borel summed) high-energy and high-momentum transfer behavior of string scattering is consistent with the space-time uncertainty principle. It is also shown that, as a consequence of this principle, string theories in 10 dimensions generically exhibit a characteristic length scale which is equal to the well-known 11 dimensional Planck length gs1/3 ℓs of M-theory as the scale at which stringy effects take over the effects of classical supergravity, even without involving D-branes directly. The implications of the space-time uncertainty relation in connection with D-branes and black holes are discussed and reinterpreted. Finally, we present a novel interpretation of the Schild-gauge action for strings from the viewpoint of noncommutative geometry. This conforms to the space-time uncertainty relation by manifestly exhibiting a noncommutativity of quantized string coordinates between, dominantly, space and time. We also discuss the consistency of the space-time uncertainty relation with S and T dualities. Copyright (c) 2000 Progress of Theoretical Physics **String Theory and the Space-Time Uncertainty Principle Tamiaki Yoneya Oxford Journals Science & Mathematics Progress of Theoretical Physics Volume 103, Issue 6Pp. 1081-112** In this Letter a recently proposed gravity dual of noncommutative Yang-Mills theory is derived from the relations between closed string moduli and open string moduli recently suggested by Seiberg and Witten. The only new input one needs is a simple form of the running string tension as a function of energy. This derivation provides convincing evidence that string theory integrates with the holographical principle and demonstrates a direct link between noncommutative Yang-Mills theory and holography.DOI: http://dx.doi.org/10.1103/PhysRevLett.84.2084 **Holography and Noncommutative Yang-Mills Theory Phys. Rev. Lett. 84, 2084 – Published 6 March 2000 Miao Li and Yong-Shi Wu Petr Hořava** suggests that M theory could be nonperturbatively equivalent to a local quantum field theory. More precisely, we present a "renormalizable" gauge theory in eleven dimensions, and show that it exhibits various properties expected of quantum M theory, most notably the holographic principle of't Hooft and Susskind. The theory also satisfies Mach's principle: A macroscopically large space-time (and the inertia of low-energy excitations) is generated by a large number of "partons" in the microscopic theory. **Petr Hořava** argues that at low energies in large eleven dimensions, the theory should be effectively described by eleven-dimensional supergravity. This effective description breaks down at much lower energies than naively expected, precisely when the system saturates the Bekenstein bound on energy density. He shows that the number of partons scales like the area of the surface surrounding the system, and discuss how this holographic reduction of degrees of freedom affects the cosmological constant problem. proposal is put forth for the holographic field theory as a candidate for a covariant, nonperturbative formulation of quantum M theory. DOI: http://dx.doi.org/10.1103/PhysRevD.59.046004 **M theory as a holographic field theory Phys. Rev. D 59, 046004 – Published 26 January 1999 Petr Hořava** The recent proposal on the correspondence between the super-Yang–Mills theory and string theory in the Penrose limit of the AdS5×S5 geometry involves a few puzzles from the viewpoint of holographic principle, especially in connection with the interpretation of times. To resolve these puzzles, we propose to interpret the PP-wave strings on the basis of tunneling null geodesics connecting boundaries of the AdS geometry. Our approach predicts a direct and systematic identification of the S-matrix of Euclidean string theory in the bulk with the short-distance structure of correlation functions of super-Yang–Mills theory on the AdS boundary, as an extension of the ordinary relation in supergravity–CFT correspondence. Holography requires an infinite number of contact terms for interaction vertices of string field theory and constrains their forms in a way consistent with supersymmetry. Copyright © 2003 Elsevier B.V. All rights reserved. **Nuclear Physics B Volume 665, 18 August 2003, Pages 94–128 Holographic reformulation of string theory on AdS5×S5 background in the PP-wave limit Suguru Dobashi, Hidehiko Shimada, Tamiaki Yoneya doi:10.1016/S0550-3213(03)00460-7** The strongest adversary in quantum information science is decoherence, which arises owing to the coupling of a system with its environment1. The induced dissipation tends to destroy and wash out the interesting quantum effects that give rise to the power of quantum computation2, cryptography2 and simulation3. Whereas such a statement is true for many forms of dissipation, **Frank Verstraete1, Michael M. Wolf2 & J. Ignacio Cirac3** show here that dissipation can also have exactly the opposite effect: it can be a fully fledged resource for universal quantum computation without any coherent dynamics needed to complement it. The coupling to the environment drives the system to a steady state where the outcome of the computation is encoded. In a similar vein, they show that dissipation can be used to engineer a large variety of strongly correlated states in steady state, including all stabilizer codes, matrix product states4, and their generalization to higher dimensions5. **Letter abstract Nature Physics 5, 633 - 636 (2009) Published online: 20 July 2009 | doi: 10.1038/nphys1342 Quantum computation and quantum-state engineering driven by dissipation Frank Verstraete1, Michael M. Wolf2 & J. Ignacio Cirac3** Nonlocal twist operators are introduced for the O (n) and Q-state Potts models in two dimensions which count the numbers of self-avoiding loops (respectively, percolation clusters) surrounding a given point. Their scaling dimensions are computed exactly. This yields many results: for example, the number of percolation clusters which must be crossed to connect a given point to an infinitely distant boundary. Its mean behaves as (1/33√π) |ln (pc−p)| as p→pc−. As an application **John Cardy** computes the exact value 3√/2 for the conductivity at the spin Hall transition, as well as the shape dependence of the mean conductance in an arbitrary simply connected geometry with two extended edge contacts. DOI: http://dx.doi.org/10.1103/PhysRevLett.84.3507 **Linking Numbers for Self-Avoiding Loops and Percolation: Application to the Spin Quantum Hall Transition Phys. Rev. Lett 84, 3507 – Published 17 April 2000 John Cardy Ferenc Iglói, Loïc Turban, Dragi Karevski, and Ferenc Szalma** consider the Ising model and the directed walk on two-dimensional layered lattices and show that the two problems are inherently related: zero-field thermodynamical properties of the Ising model are contained in the spectrum of the transfer matrix of the directed walk. The critical properties of the two models are connected to the scaling behavior of the eigenvalue spectrum of the transfer matrix which is studied exactly through renormalization for different self-similar distributions of the couplings. The models show very rich bulk and surface critical behaviors with nonuniversal critical exponents, coupling-dependent anisotropic scaling, first-order surface transition, and stretched exponential critical correlations. It is shown that all the nonuniversal critical exponents obtained for the aperiodic Ising models satisfy scaling relations and can be expressed as functions of varying surface magnetic exponents. DOI: http://dx.doi.org/10.1103/PhysRevB.56.11031 **exact renormalization-group study of aperiodic Ising quantum chains and directed walks Phys. Rev. B 56, 11031 – Published 1 November 1997 Ferenc Iglói, Loïc Turban, Dragi Karevski, and Ferenc Szalma** Using exact expressions for the persistence probability and for the leading eigenvalue of the Fokker-Planck operator of a random walk in a random environment, we establish a fundamental relation between the statistical properties of anomalous diffusion and the critical and off-critical behavior of random quantum spin chains. Many exact results are obtained from this correspondence, including the space and time correlations of surviving random walks and the distribution of the gaps of the corresponding Fokker-Planck operator. In turn **Ferenc Iglói and Heiko Rieger** derives analytically the dynamical exponent of the random transverse-field Ising spin chain in the Griffiths-McCoy region. DOI: http://dx.doi.org/10.1103/PhysRevE.58.4238 **Anomalous diffusion in disordered media and random quantum spin chains Phys. Rev. E 58, 4238 – Published 1 October 1998 Ferenc Iglói and Heiko Rieger** To gain deeper insight into the dynamics of complex quantum systems we need a quantum leap in computer simulations. We cannot translate quantum behaviour arising from superposition states or entanglement efficiently into the classical language of conventional computers. The solution to this problem, proposed in 1982 (ref. 1), is simulating the quantum behaviour of interest in a different quantum system where the interactions can be controlled and the outcome detected sufficiently well. **A. Friedenauer1, H. Schmitz1, J. T. Glueckert, D. Porras & T. Schaetz** study the building blocks for simulating quantum spin Hamiltonians with trapped ions2. They experimentally simulate the adiabatic evolution of the smallest non-trivial spin system from paramagnetic into ferromagnetic order with a quantum magnetization for two spins of 98%. We prove that the transition is not driven by thermal fluctuations but is of quantum-mechanical origin (analogous to quantum fluctuations in quantum phase transitions3). We observe a final superposition state of the two degenerate spin configurations for the ferromagnetic order (|↑↑right fence+|↓↓right fence), corresponding to deterministic entanglement achieved with 88% fidelity. This method should allow for scaling to a higher number of coupled spins2, enabling implementation of simulations that are intractable on conventional computers. **Letter Nature Physics 4, 757 - 761 (2008) Published online: 27 July 2008 | doi:10.1038/nphys1032 Subject Categories: Quantum physics | Atomic and molecular physics Simulating a quantum magnet with trapped ions A. Friedenauer1, H. Schmitz1, J. T. Glueckert, D. Porras & T. Schaetz** This article gives a comprehensive description of the fractal geometry of conformally-invariant (CI) scaling curves, in the plane or half-plane. It focuses on deriving critical exponents associated with interacting random paths, by exploiting an underlying quantum gravity (QG) structure, which uses KPZ maps relating exponents in the plane to those on a random lattice, i.e., in a fluctuating metric. This is applied to critical models, like O(N) and Potts models, and to the Stochastic L\"owner Evolution (SLE). The multifractal (MF) function f(alpha, c) of the harmonic measure near any CI fractal boundary, is given as a function of the central charge c of the associated CFT. The Hausdorff dimensions D_{H} of a non-simple scaling curve or cluster hull, and D_{EP} of its external perimeter or frontier, are shown to obey the duality equation (D_{H}-1)(D_{EP}-1)=1/4, valid for any c. The universal mixed MF spectrum f(alpha,lambda;c) describing the local spiralling rate lambda and singularity exponent alpha of the potential near any CI scaling curve is given. The duality between simple and non-simple random paths is established via symmetry of the KPZ quantum gravity map. An extended dual KPZ relation is introduced for the SLE_{kappa}, which commutes with the kappa to kappa'=16/kappa duality. This gives the SLE exponents from simple QG rules, established from the general structure of correlation functions of arbitrary interacting random sets on a random lattice. Journal reference: {\it Fractal Geometry and Applications: A Jubilee of Beno\^{i}t Mandelbrot} (M. L. Lapidus and M. van Frankenhuysen, eds.), Proc. Symposia Pure Math. vol. 72, Part 2, 365-482 (AMS, Providence, R.I., 2004) arXiv: math-ph/0303034(or arXiv: math-ph/0303034v2 for this version) **Conformal Fractal Geometry and Boundary Quantum Gravity Bertrand Duplantier** Hume, For Deleuze, Considers The Mind To Be A System Of Associations Alone, A Network Of Tendencies (ES 25): “We Are Habits, Nothing But Habits – The Habit Of Saying ‘I’. Perhaps There Is No More Striking Answer To The Problem Of The Self.” (ES X.) The Mind, Affected By The Natural Principle Of Association, Becomes Human Nature, From The Ground Up: Empirical Subjectivity Is Constituted In The Mind Under The Influence Of The Principles Affecting It; The Mind Therefore Does Not Have The Characteristics Of A Preexisting Subject. (ES 29) These Associations Account Not Only for Experience in the Basic Sense, But up To the Highest Level of Social and Cultural Life: This Is The Basis For Hume’s Rejection (E) Of A Social Contract Model Of Society (Such As Hobbes’), In Favour Of Convention Alone. Morals, Feelings, Bodily Comportment, All Of These Elements Of Subjectivity Are Explained, Not By Transcendental Structures, Such As Kant Will Propose, But By The Immanent Activity Of Association. Once This Habitual Structure Of The Self Is In Place, Deleuze Suggests, The Humean Concept Of Belief Comes Into Play , Which Is Resolutely A Central Part Of Human Nature. It Describes The Particularly Human Way Of Going Beyond The Given. When We Expect The Sun To Come Up Tomorrow, We Do Not Do So Because We Know That It Will, But Because Of A Belief Based On A Habit. This In Turn Reverses The Hierarchy Of Knowledge And Belief, And Results, For Deleuze, In A, “Great Conversion Of Theory To Practice.” (PI 36) Every Act Of Belief Is A Practical Application Of Habit, Without Any Reference To An A Priori Ability To Judge. Not Only Is The Human Being Thus Habitual, On Deleuze’s Reading, But Also Creative Even In The Most Mundane Moments Of Life. Finally, Deleuze Insists That One Of Hume’s Greatest Contributions To Modern Philosophy Is His Insistence That All Relations Are External To Their Terms: This Is The Essence Of Hume’s Anti-Transcendental Stance. Human Nature Cannot Unite Itself, There Is No ‘I’ Which Stands Before Experience, But Only Moments Of Experience Themselves, Unattached And Meaningless Without Any Necessary Relation To Each Other. A Flash Of Red, A Movement, A Gust Of Wind, Dashing Of A Woman Against You, Obscene Gestures, Spitting At You, Talking Extempore About You (My Addition) And These Elements Must Be Externally Related To Each Other To Create The Sensation Of A Tree In Autumn. In The Social World, This Externality Attests To The Always-Already Interested Nature Of Life: No Relation Is Necessary, Or Governed By Neutral Laws, So Every Relation Has A Localised And Passional Motive. The Ways In Which Habits Are Formed Attests To The Desires At The Heart Of Our Social Milieu. Subjectivity, As Deleuze Describes It Through His Reading Of Hume, Is A Practical, Passional, And Empiricist Concept, Immediately Located At The Heart Of The Conventional, Which Is To Say The Social. (Stanford Encyclopedia of Philosophy). The Buddha Always Used The Terms Void, No Rising And Falling, Calmness And Extinction To Explain The Profound Meaning Of Sunyata And Cessation. For Example, Sunyata And The State Of Nirvana Where There Is No Rising Nor Falling, Are Interpreted By Most People As A State Of Non-Existence And Gloom. They Fail To Realise That Quite The Opposite, Sunyata Is Of Substantial And Positive Significance. The Sutras Often Use The Word "Great Void" To Explain The Significance Of Sunyata. In General, We Understand The "Great

Void" As Something That Contains Absolutely Nothing. However, From A Buddhist Perspective, The Nature Of The "Great Void" Implies Something Which Does Not Obstruct Other Things, In Which All Matters Perform Their Own Functions. Materials Are Form, Which By Their Nature, Imply Obstruction. The Special Characteristic Of The "Great Void" Is Non-Obstruction. The "Great Void" Therefore, Does Not Serve As An Obstacle To Them. Since The "Great Void" Exhibits No Obstructive Tendencies, It Serves As The Foundation For Matter To Function. In Other Words, If There Was Neither "Great Void" Nor Characteristic Of Non-Obstruction, It Would Be Impossible For The Material World To Exist And Function. The "Great Void" Is Not Separated From The Material World. The Latter Depends On The Former. We Can State That the Profound Significance of Sunyata and the Nature of Sunyata in Buddhism Highlight The "Great Void's" Non-Obstructive Nature. Sunyata Does Not Imply The "Great Void". Instead, It Is The Foundation Of All Phenomena (Form And Mind). It Is The True Nature Of All Phenomena, And It Is The Basic Principle Of All Existence. In Other Words, If The Universe's Existence Was Not Empty Nor Impermanent, Then All Resulting Phenomena Could Not Have Arisen Due To The Co-Existence Of Various Causes And There Would Be No Rising Nor Falling. The Nature Of Sunyata Is Of Positive Significance. Calmness And Extinction Are The Opposite Of Rising And Falling. They Are Another Way To Express That There Is No Rising And Falling. Rising And Falling Are The Common Characteristics Of Worldly Existence. All Phenomena Are Always In The Cycle Of Rising And Falling. However, Most People Concentrate On Living (Rising). They Think That The Universe And Life Are The Reality Of A Continuous Existence. Buddhism On The Other Hand, Promotes The Value Of A Continuous Cessation (Falling). This Cessation Does Not Imply That It Ceases To Exist Altogether. Instead, It Is Just A State In The Continuous Process Of Phenomena. In This Material World, Or What We May Call This "State Of Existence", Everything Eventually Ceases To Exist. Cessation Is Definitely The Home Of All Existences. Since Cessation Is The Calm State Of Existence And The Eventual Refuge Of All Phenomena, It Is Also The Foundation For All Activities And Functions. Teachings In Chinese Buddhism (6) Sunyata (Emptiness) In The Mahayana Context (Wikipedia) Studies by Eric V. Linder about geometric dark energy bring out the quintessential prerequisites about the extreme physics ad dark matter**.** The acceleration of the expansion of the universe arises from unknown physical processes involving either new fields in high energy physics or modifications of gravitation theory. It is crucial for our understanding to characterize the properties of the dark energy or gravity through cosmological observations and compare and distinguish between them. In fact, close consistencies exist between a dark energy equation of state function w(z) and changes to the framework of the Friedmann cosmological equations as well as direct spacetime geometry quantities involving the acceleration, such as "geometric dark energy" from the Ricci scalar. We investigate these interrelationships, including for the case of super acceleration or phantom energy where the fate of the universe may be gentler than the Big Rip. DOI: http://dx.doi.org/10.1103/PhysRevD.70.023511 **Probing gravitation, dark energy, and acceleration Phys. Rev. D 70, 023511 – Published 28 July 2004 Eric V. Linder. In the same vein he continues to question the number of parameters that exists in dark energy** .How many dark energy parameters? For exploring the physics behind the accelerating Universe a crucial question is how much we can learn about the dynamics through next generation cosmological experiments. For example, in defining the dark energy behavior through an effective equation of state, how many parameters can we realistically expect to tightly constrain? Through both general and specific examples (including new parametrizations and principal component analysis) we argue that the answer is two. Cosmological parameter analyses involving a measure of the equation of state value at some epoch (e.g. w0) and a measure of the change in equation of state (e.g. w′) are therefore realistic in projecting dark energy parameter constraints. More elaborate parametrizations could have some uses (e.g. testing for bias or comparison with model features), but do not lead to accurately measured dark energy parameters. DOI: http://dx.doi.org/10.1103/PhysRevD.72.043509 **Phys. Rev. D 72, 043509 – Published 11 August 2005 Eric V. Linder and Dragan Huterer D.F. Mota, C. van de Bruck Oxford Univ** study the spherical collapse model in dark energy cosmologies, in which dark energy is modelled as a minimally coupled scalar field. We first follow the standard assumption that dark energy does not cluster on the scales of interest. Investigating four different popular potentials in detail, we show that the predictions of the spherical collapse model depend on the potential used. We also investigate the dependence on the initial conditions. Secondly, they investigate in how far perturbations in the quintessence field affect the predictions of the spherical collapse model. In doing so, we assume that the field collapses along with the dark matter. Although the field is still subdominant at the time of virialisation, the predictions are different from the case of a homogeneous dark energy component. This will in particular be true if the field is non--minimally coupled. **D.F. Mota, C. van de Bruck** conclude that a better understanding of the evolution of dark energy in the highly non--linear regime is needed in order to make predictions using the spherical collapse model in models with dark energy. Astrophys 421 (2004) 71-81DOI:10.1051/0004-6361:20041090arXiv: astro-ph/0401504 **on the spherical collapse model in dark energy cosmologies D.F. Mota, C. van de Bruck (Oxford Univ)** Studies by Eric V. Linder about geometric dark energy bring out the quintessential prerequisites about the extreme physics ad dark matter**.** The acceleration of the expansion of the universe arises from unknown physical processes involving either new fields in high energy physics or modifications of gravitation theory. It is crucial for our understanding to characterize the properties of the dark energy or gravity through cosmological observations and compare and distinguish between them. In fact, close consistencies exist between a dark energy equation of state function w(z) and changes to the framework of the Friedmann cosmological equations as well as direct spacetime geometry quantities involving the acceleration, such as "geometric dark energy" from the Ricci scalar. We investigate these interrelationships, including for the case of super acceleration or phantom energy where the fate of the universe may be gentler than the Big Rip. DOI: http://dx.doi.org/10.1103/PhysRevD.70.023511 **Probing gravitation, dark energy, and acceleration Phys. Rev. D 70, 023511 – Published 28 July 2004 Eric V. Linder. In the same vein he continues to question the number of parameters that exists in dark energy** .How many dark energy parameters? For exploring the physics behind the accelerating Universe a crucial question is how much we can learn about the dynamics through next generation cosmological experiments. For example, in defining the dark energy behavior through an effective equation of state, how many parameters can we realistically expect to tightly constrain? Through both general and specific examples (including new parametrizations and principal component analysis) we argue that the answer is two. All Existences Exhibit Void-Nature And Nirvana-Nature. These Natures Are The Reality Of All Existence. To Realise The Truth, We Have To Contemplate And Observe Our Worldly Existence. We Cannot Realise The Former Without Observing The Latter. Consider This Heart Sutra Extract, "Only When Avalokiteshvara Bodhisattva Practised The Deep Course Of Wisdom Of Prajna Paramita Did He Come To Realise That The Five Skandhas (Aggregates, And Material And Mental Objects) Were Void." Profound Wisdom Leads Us To The Realisation That All Existences Are Of Void-Nature. The Sutras Demonstrate That The Profound Principle Can Be Understood By Contemplating And Observing The Five Skandhas. We Cannot Realise The Truth By Seeking Something Beyond The Material And Mental World. The Buddha, Using His Perfect Wisdom, Observed Worldly Existence From Various Implications And Aspects, And Came To Understand All Existences. Teachings In Chinese Buddhism (6) Sunyata (Emptiness) In The Mahayana Context (Wikipedia) .But From The Profound Contemplation And Wisdom Of The Buddha And Mahabodhisattvas, We Know There Is No Such Reality. Instead, Egolessness (Non-Self) Is The Only Path To Understand The Reality Of The Deluded Life. All Existences Are Subject To The Law Of Causes And Conditions. These Include The Smallest Particles, The Relationship Between The Particles, The Planets, And The Relationship Between Them, Up To And Including The Whole Universe! From The Smallest Particles To The Biggest Matter, There Exists No Absolute Independent Identity. Egolessness (Non-Self) Implies The Void Characteristics Of All Existence. Egolessness (Non-Self) Signifies The Non-Existence Of Permanent Identity For Self And Existence (Dharma). Sunyata Stresses The Voidness Characteristic Of Self And Existence (Dharma). Sunyata And Egolessness Possess Similar Attributes. As We Have Discussed Before, We Can Observe The Profound Significance Of Sunyata From The Perspective Of Inter-Dependent Relationships. Considering Dharma-Nature And The Condition Of Nirvana, All Existences Are Immaterial And Of A Void-Nature. Then We See Each Existence As Independent Of Each Other. But Then We Cannot Find Any Material That Does Exist Independent Of Everything Else. So Egolessness Also Implies Void-Nature! From The Observation Of All Existences, We Can Infer The Theory Of Nirvana And The Complete Cessation Of All Phenomena. From The Viewpoint Of Phenomena, All Existences Are So Different From Each Other, That They May Contradict Each Other. They Are So Chaotic. In Reality, Their Existence Is Illusionary And Arises From Conditional Causation. They Seem To Exist On One Hand, And Yet Do Not Exist On The Other. They Seem To Be United, But Yet They Are So Different To One Another. They Seem To Exist And Yet They Do Cease!

Ultimately Everything Will Return To Harmony And Complete Calmness. This Is The Nature Of All Existence. It Is The Final Resting Place For All. If We Can Understand This Reality And Remove Our Illusions, We Can Find This State Of Harmony And Complete Calmness. Teachings In Chinese Buddhism (6) Sunyata (Emptiness) In The Mahayana Context (Wikipedia) All Our Contradictions, Impediments And Confusion Will Be Converted To Equanimity. Free From Illusion, Complete Calmness Will Be The Result Of Attaining Nirvana. The Buddha Emphasised The Significance Of This Attainment And Encouraged The Direct And Profound Contemplation On Void-Nature. He Said, "Since There Is No Absolute Self-Nature Thus Every Existence Exhibits Void-Nature. Because It Is Void, There Is No Rising Nor Falling. Since There Is No Rising Nor Falling, Thus Everything Was Originally In Complete Calmness. Its Self-Nature Is Nirvana." Teachings In Chinese Buddhism (6) Sunyata (Emptiness) In The Mahayana Context (Wikipedia).The Scholars Of Tien Tai Called It The "Embodied Nature". (This Is The Buddha-Nature That Includes Both Good And Evil.) The Scholars Of Xian Shou Say, "It Is Arising From Primal Nature", And The Scholars Of Chan (Zen) Say, "It Is Nature That Causes The Rising Of Things". All Dharma Is Dharma-Nature. It Is Not Different From Dharma-Nature. Dharma And Dharma-Nature Are Not Two Separate Identities, "Phenomena" And "Nature" Is Also Not Distinguishable Either. In Other Words, There Is No Difference Between Principle (Absolute) And Practice (Relative). Teachings In Chinese Buddhism (6) Sunyata (Emptiness) In The Mahayana Context (Wikipedia). In Other Words, All Dharma Arises From Causes And Conditions, And All Dharma Is Empty In Nature. The Law of Dependent Origination (Existence) And The Nature Of Emptiness Is Neither The Same Nor Different. They Exist Mutually. The Truth Of "Sunyata" And "Existence", And "Nature" And "Phenomena" Are Not In Conflict With Each Other. Unlike The Scholars Of The Dharmalaksana Sect Who Explain The Dharma Only From The Aspect Of Dependent Origination, Or The Scholars Of Dharma-Nature That Explain The Existence Of Dharma Only From The Aspect Of Dharma-Nature, The Scholars Of Madhyamika Explain The Truth Of The Dharma From Both Aspects. Hence This Is Called The Middle Path Which Does Not Incline To Either Side. Teachings In Chinese Buddhism (6) Sunyata (Emptiness) In The Mahayana Context (Wikipedia) **C S Lent, P D Tougaw, W Porod and G H Bernstein** formulate a new paradigm for computing with cellular automata (CAS) composed of arrays of quantum devices-quantum cellular automata. Computing in such a paradigm is edge driven. Input, output, and power are delivered at the edge of the CA array only; no direct flow of information or energy to internal cells is required. Computing in this paradigm is also computing with the ground state. The architecture is so designed that the ground-state configuration of the array, subject to boundary conditions determined by the input, yields the computational result. proposal is put forth for a specific realization of these ideas using two-electron cells composed of quantum dots. The charge density in the cell is very highly polarized (aligned) along one of the two cell axes, suggestive of a two-state CA. The polarization of one cell induces a polarization in a neighboring cell through the Coulomb interaction in a very non-linear fashion. Quantum cellular automata can perform useful computing. The authors show that AND gates, OR gates and inverters can be constructed and interconnected. **C S Lent et al 1993 Nanotechnology 4 49 doi:10.1088/0957-4484/4/1/004 Quantum cellular automata C S Lent, P D Tougaw, W Porod and G H Bernstein** The basic features of the dynamics of open quantum systems, such as the dissipation of energy, the decay of coherences, the relaxation to equilibrium or non-equilibrium stationary state, and the transport of excitations in complex structures are of central importance in many applications of quantum mechanics. The theoretical description, analysis and control of non-Markovian quantum processes play an important role in this context. While in a Markovian process an open system irretrievably loses information to its surroundings, non-Markovian processes feature a flow of information from the environment back to the open system, which implies the presence of memory effects and represents the key property of non-Markovian quantum behaviour. **Heinz-Peter Breuer** review recent ideas developing a general mathematical definition for non-Markovianity in the quantum regime and a measure for the degree of memory effects in the dynamics of open systems, which are based on the exchange of information between system and environment. **Heinz-Peter Breuer** further study the dynamical effects induced by the presence of system–environment correlations in the total initial state and design suitable methods to detect such correlations through local measurements on the open system. **Heinz-Peter Breuer 2012 J. Phys. B: At. Mol. Opt. Phys. 45 154001 doi:10.1088/0953-4075/45/15/154001 Foundations and measures of quantum non-Markovianity** A fundamental step towards atomic- or molecular-scale spintronic devices has recently been made by demonstrating that the spin of an individual atom deposited on a surface1, or of a small paramagnetic molecule embedded in a nanojunction2, can be externally controlled. An appealing next step is the extension of such a capability to the field of information storage, by taking advantage of the magnetic bistability and rich quantum behaviour of single-molecule magnets3, 4, 5, 6 (SMMs). Recently, a proof of concept that the magnetic memory effect is retained when SMMs are chemically anchored to a metallic surface7 was provided. However, control of the nanoscale organization of these complex systems is required for SMMs to be integrated into molecular spintronic devices8, 9. Here we show that a preferential orientation of Fe4 complexes on a gold surface can be achieved by chemical tailoring. As a result, the most striking quantum feature of SMMs—their stepped hysteresis loop, which results from resonant quantum tunnelling of the magnetization5, 6—can be clearly detected using synchrotron-based spectroscopic techniques. With the aid of multiple theoretical approaches, **M. Mannini et al** relate the angular dependence of the quantum tunnelling resonances to the adsorption geometry, and demonstrate that molecules predominantly lie with their easy axes close to the surface normal. Findings of **M. Mannini et al prove** that the quantum spin dynamics can be observed in SMMs chemically grafted to surfaces, and offer a tool to reveal the organization of matter at the nanoscale. **Quantum tunnelling of the magnetization in a monolayer of oriented single-molecule magnets M. Mannini et al** Nature 468, 417–421 (18 November 2010) doi: 10.1038/nature09478 Supposing That There Were Indeed An "Energy Of Contraction" Constant In All Centers Of Force Of The Universe, It Remains To Be Explained Where Any Difference Would Ever Originate. It Would Be Necessary For The Whole To Dissolve Into An Infinite Number Of Perfectly Identical Existential Rings And Spheres, And We Would Therefore Behold Innumerable And Perfectly Identical Worlds COEXISTING [Nietzsche Underlines This Word Twice] Alongside Each Other. Is It Necessary For Me To Admit This? Is It Necessary To Posit An Eternal Coexistence On Top Of The Eternal Succession Of Identical Worlds? The Eternal Return: Genesis And Interpretation BY PAUL D'IORIO"The Cyclical Hypothesis, So Heavily Criticized By Nietzsche (VP II 325 And 334), Arises In This Way." In Fact, Nietzsche Was Not Criticizing The Cyclical Hypothesis But Only The Particular Form Of That Hypothesis Presented In Vogt's Work. All Of Nietzsche's Texts Without Exception Speak Of The Eternal Return As The Repetition Of The Same Events Within A Cycle Which Repeats Itself Eternally. If Deleuze's Interpretation Holds That The Eternal Return Is Not A Circle, Then What Is It? A Wheel Moving Centrifugally, Operating A "Creative Selection," "Nietzsche's Secret Is That The Eternal Return Is Selective" Says Deleuze: The Eternal Return Produces Becoming-Active. It Is Sufficient To Relate The Will To Nothingness To The Eternal Return In Order To Realize That Reactive Forces Do Not Return. However Far They Go, However Deep The Becoming-Reactive Of Forces, Reactive Forces Will Not Return. The Small, Petty, Reactive Man Will Not Return. Affirmation Alone Returns, This That Can Be Affirmed Alone Returns, Joy Alone Returns. Everything That Can Be Denied, Everything That Is Negation, Is Expelled Due To The Very Movement Of The Eternal Return. We Were Entitled To Dread That The Combinations Of Nihilism And Reactivity Would Eternally Return Too. The Eternal Return Must Be Compared To A Wheel; Yet, The Movement Of The Wheel Is Endowed With Centrifugal Powers That Drive Away The Entire Negative. Because Being Imposes Itself On Becoming, It Expels From Itself Everything That Contradicts Affirmation, All Forms Of Nihilism And Reactivity: Bad Conscience, Ressentiment..., We Shall Witness Them Only Once. [...] The Eternal Return Is The Repetition, But The Repetition That Selects, The Repetition That Saves. Here Is The Marvelous Secret Of A Selective And Liberating Repetition. There Is No Need To Remind The Reader That Neither The Image Of A Centrifugal Movement Nor The Concept Of A Negativity-Rejecting Repetition Appears Anywhere In Nietzsche's Writings, And Indeed Deleuze Does Not Refer To Any Text In Support Of This Interpretation. Further, One Could Highlight That Nietzsche Never Formulates The Opposition Between Active And Reactive Forces, Which Constitutes The Broader Framework Of Deleuze's Interpretation. For Some Years, Marco Brusotti Has Called Attention To The Fact That Deleuze Introduced A Dualism That Does Not Exist In Nietzsche's Writings. To Be Sure, The German Philosopher Describes A Certain Number Of "Reactive" Phenomena (For Example, In The Second Essay Of The Genealogy Of Morality, § 11, He Talks About "Reactive Affects" [Reaktive Affekte], "Reactive Feelings" [Reaktive Gefühlen], Reactive Men [Reaktive Menschen]); But These Are Nonetheless The Result Of Complex Ensembles Of Configurations Of Centers Of Forces That Remain In

Themselves Active. Neither The Word Nor The Concept Of "Reactive Forces" Ever Appears In Nietzsche's Philosophy. The Eternal Return: Genesis And Interpretation BY PAUL D'IORIO Some Parts Are Deleted Due To Spatial Constraints. Please Pardon Me For The Deletion. Deleuze Opposes The Historical Course Of The Hegelian Notion That Confronts Struggles And Finally Dialectizes The Negative And Results In A Consoling Teleology Leading To The Triumph Of The Idea Or The Liberation Of The Masses With The Centrifugal Movement Of The Wheel, Which Simply Ejects The Negative. It Is Still A Case Of A Consoling And Optimistic Teleology, Which, Instead Of Confronting The Weight Of History, The Grief And The Negative, Makes It Disappear In One Centrifugal Stroke Of A Magic Wand. There Is Reason To Worry That This Be A Case Of Repression, Which, Unable To Dialectize Or Accept The Negative, Simply Seeks To Exorcise It In One Gesture Of "Creative Selection." But Exorcism Is A Feat Of Magic And Not Of Philosophy: It Is Unfortunately Not Enough To Make The Negative Disappear. In All Probability, The Negative Will Come Back With A Vengeance. In Contrast To Deleuze's "Affirmation Of Affirmation", Which Affirms Only Affirmation, Nietzsche Conceives Of The Eternal Return From A Rigorously Non-Teleological Perspective As The Accomplishment Of A Philosophy Strong Enough To Accept Existence In All Its Aspects, Even The Most Negative, Without Any Need To Dialecticize Them, Without Any Need To Exclude Them By Way Of Some Centrifugal Movement Of Repression. It Denies Nothing And Incarnates Itself In A Figure Similar To The One Nietzsche, In Twilight Of The Idols, Draws Of Goethe: Such A Spirit, Who Has Become Free Stands In The Middle Of The World With A Cheerful And Trusting Fatalism In The Belief That Only The Individual Is Reprehensible, That Everything Is Redeemed And Affirmed In The Whole-He Does Not Negate Anymore. Such A Faith However, Is The Highest Of All Possible Faiths: I Have Baptized It With The Name Of Dionysus. The Eternal Return: Genesis and Interpretation BY PAUL D'IORIO The Most Complete Theory Of Mind That Comports With The Holographic Principle Of Mind, As Developed Here, Is The Microgenetic Theory Of Neurologist Jason Brown. Brown (2005) Presents An Evolutionary Theory Of Values, Morals, And Ethics, Building On The Microgenetic Theory And Process Theory Of His Earlier Works (1988, 1991, 1996, 1998, And 2000). Brown Is Work Has Been A Progression That Began With The Study Of Brain Processes In Neurological Subjects With Brain Injuries Or Lesions. In His Earlier Work (Brown, 1988; 1991) He Described The Process Of Microgenesis As A Process Of Elaboration Of Mental Contents In An Evolutionary And Developmental Hierarchy Of Brain Structures Within The Process Of The Genesis Of The Mental State, And Related The Hierarchy Of The Genesis Of The Mental State To Disturbances Of Language Comprehension Or Expression (Aphasia), Of Knowledge (Agnosia), And Or Purposeful Movement (Apraxia). The Fundamental Neurology Of These Disturbances Had Been Described In Brownís Previous Work (1972, 1988), And In The Seminal Work Of The Russian Neurologist And Neuropsychologist, Alexander Luria (1966). Brown (1988, 1991, 1996, 1998) Created A Process Theory Of Mind On The Basis Of His Neurological Observations, And Went On From His Neurological Work To Incorporate Process Theory In Philosophy, As Developed Principally By Henri Bergson (1911/1998). And Alfred North Whitehead (1925/1953, 1929/1978). Bergson Had Pioneered The Concept Of An Irreducible Duration Of Experience. This Concept Was Elaborated By Whitehead, In Keeping With Discontinuities Of Particles, As "Actual Entities" Of A Rudimentary Sort, As They Make "Quantum Leaps" Along Their Trajectories, Halting Or Persisting At A Given Location For A Short Period Of Time Or Duration Before Leaping To The Next. Whitehead Employed These "Quantum Leaps" To The Process By Which Experience Arises In "Actual Entities" At The Most Fundamental Level Of Actuality, Through The Epochal Or Halting Duration Of A Discontinuous Process (Whitehead, 1925/1953, 1929/1978). This Halting Allows Actual Entities To Participate In A Process Of Internal Relations, Relations On The "Inside" Of Things. According The Holographic Principle, This "Inside" Is In The Holographic Surface Of The Relevant Region Of Spacetime Of The Actual Entity, And Within Other Surfaces That Are Non-Locally Connected With That Surface. The Holographic Surface Is Thus The Locus Of Non-Local Information And Experience, In Our Interpretations Of Whitehead Is Metaphysics. Internal Relations Occur Through Feeling, Or "Prehension," Which Is Nothing More Than The Subjective Quality Of Non-Local Experience. The Internal Relations Of The Becoming Entity Occur In A Seriality Of Prior Becomings Of The Actual Entity, With The Entity Inheriting All Of Its Causal Past As Well As Its Relevant Feelings Or Prehensions From Prior "Occasions" Or Quanta Of Experience. This Process Is, In The Holographic Model, The Process By Which Former

Surfaces, Now-Pasts, Are Elaborated On To The Now-Present. Prehensions Also Occur With Other Actual Entities Throughout The Universe, With Which They Are Non-Locally Connected, And With Neo-Platonic "Eternal Objects," Existing In An Eternal Heaven. The "Ingression" Of Eternal Objects Is Fundamental To Each Duration Of Becoming Of The Entity, And, On This Basis, Whitehead Formulated The Notion Of An Eternal Heaven In Constant Intercourse All Of Its Creation. There Are Clear Parallels Between Whitehead's Cosmology And The Cosmology Introduced Here According To The Holographic Principle, In That The "Heaven" May Be Regarded As The Holographic Boundary, In Constant Intercourse With The Relevant Volume Of Spacetime. This Interconnection Of Feelings Or Prehensions, According To Their Relevance, Produces Intensities And Contrasts Which Give Rise To The Creative Advance, Which, For Whitehead (1929/1978) Is The Process Which Impels The Movement From The Physical To The Mental Pole Of Process. With Each Halting, Internally-Timeless Duration There Is A Concrescence Or Integration Of These Feelings, Which, When Complete, Constitutes A New Actual Entity Or Actual Occasion (They Are The Same Thing) At A New Locus In Spacetime. This Movement To A New Locus, Or Transition, Is, Fundamentally, The Quantum Leap. MICROGENESIS AND THE HOLOGRAPHIC PRINCIPLE The Holographic Principle Theory Of Mind MARK GERMINE Institute For Psycho Science If the Holographic Principle is true, than it must be the fundamental principle of mind. The brain has no way around the Holographic Principle. For the reductionist, the Holographic Principle is the ultimate reduction. It applies to the most minuscule level of what we can observe, and beyond. For the Universalist, the Holographic Principle gives us the ultimate universal. It extends to the limit of our Universe, the Universal holographic boundary, and beyond. For the Phenomenalist, the Holographic Principle gives us the ultimate ground of our phenomenal perception, our grounding in the Universal "now," in the now-present of the Universal holographic boundary, moving outward from now-pasts to now-futures. Wheeler (1988) has said that all of reality is information, and that other physical quantities are "mere incidentals." Information monism is gaining popularity in physics. By breaking the dichotomy of between information and experience, we find a deep connection between Wheeler is monism and the experiential monism of Whitehead, sometimes called panexperientialism, which relates to the later theological concept of his student, Charles Hartshorne, panentheism, God inside of everything (Hartshorne, 1964). There thus seems to be a convergence of the concepts of information, experience, and spirituality. There is not one universe, but many parallel universes, or, more accurately, a vast superposition of universes called the multiverse (Penrose, 2004). However, as explained in our treatment of the double-slit experiment, in the observation of events on the quantum level, the individual observer sees only one of these vast superpositions, not a summation of a vast number of potentials. This has been explained in terms of the many worlds or many minds theories, in which there are multiple copies of the same observing individual, but this particular issue remains unresolved, leaving physics ungrounded in reality (Penrose, 2004). The concept of One Mind is not only more parsimonious than that of many minds, but also lets us out of the bizarre and counterintuitive idea that there are multiple copies of our own selves, which exist as mere potential, and are thus not actual. There are many possible universes, but there is only One Mind, which determines events on the quantum level, and thus creates our Universe. As we had discussed previously, the quantum level provides the essential ground of the Holographic Principle, such that quantum-level holographic surfaces are elaborated at higher levels, manifesting higher orders of information from the quantum "world." In this process, there is a reduction of the wave function or potentialities of quantum fields. At the level of consciousness, this entails freedom to choose which observations we make (Stapp, 1997), which gives us the capacity to think and to make decisions. These capacities are the basis of individuality, self-determination, judgment, and values. The progressive evolution of the manifestation of Mind through higher orders of experience, leading to higher orders of consciousness, is entailed by the Holographic Principle. Again, we are dealing here with levels of description, with the multiverse of all potentials fundamentally supporting the single Universe we collectively observe. The multiverse is the wave function of the Universe (Penrose, 2004). The recursive integration of nested hierarchies of holographic surfaces brings out a single actuality in consciousness from a wave function that is unconscious. Consciousness thus gives us information at a level of experience that is causal. In this sense, we partake in the creation of the Universe. We participate in creation, and this participation, when fully realized, leads us to higher levels of consciousness and of realization. As a system, the biosphere that we live in has a holographic surface, creating a deep sense of ecology as we collectively move toward a planetary consciousness. It is only when the Universal Holographic Boundary reaches the information storage and processing capacity needed for the requisite biological and biochemical complexity that consciousness evolves in living things. This evolution is natural and spontaneous, since consciousness gives rise to what is actual, as opposed to what is merely potential. In this sense, consciousness is still in the process of creating our Universe, and levels of higher consciousness will continue to evolve. We are all in the same "now," and that now is defined by the present Universal Boundary. This assures us that our experience is Universal, and does not pass with time. This is the fundamental basis of memory and of cognition. The identity of mind and brain is a myth. We have a continual, internal or non-local relation with the Universe, as it has with us. Once this mystery is resolved, the myth is no longer needed, and there is a confluence of science and spirituality.Experience is primary, information is secondary. We can only gather information from experience, whether it is in the laboratory or in life. We cannot measure the information on the surfaces of systems. The physicists that have formulated the Holographic Principle for all systems are quite aware of this, or else the principle would have been established or discredited. We cannot measure what we experience. It is intangible, yet it is all we know to be actual. Everything else is inferred. Because it cannot be measured, it has been fundamentally disregarded by mainstream science. Materialism is considered scientific, while idealism is considered unscientific. But arenít ideas, fundamentally, made of information? Brain science has mistaken the representation of information for information itself, and has tied those representations to matter and energy. Consciousness, the highest order of information, has generally been regarded as superfluous, something that needs to explained away, or altogether ignored. Yet it is the only "thing" that reaches our awareness. Consciousness comes at a price. For everything that becomes conscious, there must be something that becomes conscious. Consciousness is certainty, and its complement, unconsciousness uncertainty. Consciousness is the particle nature of experience. It has definiteness about it. The unconscious is the wave nature of experience, it is like the metaphysical cloud of unknowing. If we are the most conscious of animals, then we must also be the most unconscious. Perhaps this is the predicament of humankind. The Holographic Principle of Mind leads us naturally from the most fundamental experiences, existing as quantum potentials from the conformations of proteins down through the fields of electrons, through their manifestation upward through a recursion or successive applications of the same holographic process, through higher levels of experience, to the emergence of consciousness as higher and higher orders of experience. The quantum Holographic Principle Mind does not require anything more quantum than is obviously present at the microscopic and submicroscopic levels, as it represents successive orders of manifestations from these levels. Recursion also applies here in the sense that it is used in computer science, in which the function of the part depends on the function of the whole. A program, as a part, cannot work without a functioning whole, the operating system. Recursive wholes which are, for us, supra-conscious, are on the group, species, planetary, and universal levels. As individuals, our consciousness cannot function without recursion to the Universal Consciousness, even though we may be unaware that such Universal Consciousness exists. Reaching upward to these supra-conscious levels is a spiritual process, making transcendence the ultimate solution to the unconscious human predicament. What was once supra-conscious becomes unconscious through a process of conditioning? We are born as creatures of the Earth and of the Universe, as evidenced by the beliefs and practices of "primitive peoples." There is evidence from cave paintings that our hominid ancestors experienced a kind of holographic perception (Combs, 1996), which could constitute our early connection with the holographic subtext of reality, and which we might then propose existed in our animal ancestors, and in extant animal species. If this is the case, than microgenesis would entail the recapitulation of this holographic experience as it progresses through our ancestral past. The supra-conscious mind seems to envelope perinatal experiences, and Stanislav Grof (1994) has developed techniques to gain access to these experiences, as well as to the earlier experiences of our human and animal ancestral lineage, and of our universal history. Grof (1994) concludes: "Our consciousness seems to have the amazing capacity to directly access the earliest history of the universe ñ witnessing dramatic sequences of the Big Bang, the formation of the galaxies, the birth of the solar system, and the early geophysical processes on this planet billions of years ago." The Holographic Principle Theory Of Mind MARK GERMINE Institute For Psycho Science. There Are Similarities Between The Patterns Of Holography And Of Psychological Transference, Where Holography Is The Process Of Recording And

Reconstructing Holograms. Employing A Theoretical Perspective Using A Hermeneutic Method, This Dissertation Parallels Holography With Transference, Offering Another Way To Encounter Transference By Showing Similarities Between The Processes Of Each And The Results Of Each. Though Complex, Infinitely Varying, And Unique, Their Patterns Are Clearly Identifiable. Thus They Are A Metaphorical Fit To The Concept Of Strange Attractors In Physics And A More Literal Fit To The Concept Of Archetypes In Depth Psychology Or Dynamic Psychology, Psychology Which Attends To The Living, Autonomous Unconscious. This Study Explains How Holography Models Transference, What A Hologram Is And How It Works, And How Depth Psychology Understands Of The Interaction Between Consciousness And The Unconscious Is Related To The Hologram. It Describes Transference And Related Psychological Processes As Understood In Six Different Schools Of Depth Psychological Thought. It Shows That The Underlying Pattern Or Strange Attraction Between Transference And Holography Extends To Other Processes Both Within And Outside The Field Of Psychology, Processes Such As Projection, Projective Identification, Splitting, Memory, Biology, Creative Discovery, Theology, Synchronicity, Chaos, And Nonlocality. By Identifying The Similar Patterns Of These Processes, This Study Demonstrates The Existence Of An Underlying Holographic Archetype In Which Essential Qualities Of The Whole Are Present In Each Of The Parts Of The Whole: The Visual Image Of The Overall Hologram Is Present In Each Component Part Of The Hologram, The Autonomy Of The Overall Human Is Present In Each Conscious And Unconscious Component Part Of The Human Psyche. By Noting Differences As Well As Similarities In These Processes, It Suggests An Inventory Of The Qualities Of The Holographic Archetype. This Study Furthers Understanding Of The Pervasiveness, Force, And Autonomy Of The Unconscious Acting Through Transference And Projection By Identifying A Group Projection Of Domestic Violence Lying At The Core Of The Christian Myth. This Study Also Furthers Understanding Of The Concept Of Transference By Providing A Reflection Hologram Of The Human Psyche As An Artistic Work And As A Visual Metaphor Of Transference. Strange Attractors: Transference, Holography, And An Archetype Burke, J. (2003). Strange Attractors: Transference, Holography, And An Archetype (Doctoral Dissertation, Pacifica Graduate Institute, 2003). Onticology, Like All Variations Of Object-Oriented Ontology, Is Realist In Its Orientation. In Defending A Realist Ontology Onticology Holds That The Vast Majorities Of Objects, Actants, Beings, Or Entities Are Independent Of Humans And Are What They Are Regardless Of Whether Any Humans Regard Them Or Register Them. In Short, Onticology Rejects Any Anthropomorphic, Idealist, Or Anti-Realist Thesis To The Effect That To Be Is To Be The Correlate Of Mind, Spirit, The Body, The Human, And Language Or Otherwise. While It Is Certainly The Case That Knowledge Is Necessarily Dependent On The Object To Which It Relates, The Converse Does Not Hold True. Objects Are Not Dependent On Being Known, Regarded, Perceived, Or Spoken About. As Such, And To Put It In Aristotelean Terms, Knowledge Is An Accident Of Objects, Not Objects An Accident Of Knowledge. As Althusser So Nicely Puts It, “[N]O Doubt There Is A Relation Between Thought-About-The-Real And This Real, But It Is A Relation Of Knowledge, A Relation Of Adequacy Or Inadequacy Of Knowledge, Not A Real Relation, Meaning By This A Relation Inscribed In That Real Of Which The Thought Is The (Adequate Or Inadequate) Knowledge” (Reading Capital, 96). Althusser Goes On To Remark That “[T] He Distinction Between A Relation Of Knowledge And A Relation Of The Real Is A Fundamental One: If We Did Not Respect It We Should Fall Irreversibly Into Either Speculative Or Empiricist Idealism” (Ibid.). Onticology Categorically Endorses Althusser’s Verdict It Is A Fundamental Necessity To Distinguish Between Those Relations That Belong To The Object And Those That Belong To Knowledge. Contemporary Philosophy Continuously Confuses These Two Very Different Sorts Of Relations. Naturally The Question Arises Of How It Is Possible To Surmount Our Relation To The Object So As To Determine Whether Objects Themselves Possess The Properties We Encounter In Relating To Objects. In Other Words, Given That We Can Only Ever Relate To The Object In Relating To The Object How Is It Possible To Surmount This Relation To Get At The Being Of The Object Itself? Much More Will Have To Be Said About This Later– And The Answers Will Be Surprising With Respect To Standard Prejudices About Realism –However, For The Moment It Can Be Said That Onticology Takes Its Epistemological Inspiration From The Transcendental Realism Of Roy Bhaskar. Among Other Things, Bhaskar Sought To Provide A Transcendental Grounding For The Sciences. Insofar As Onticology Defends The Thesis That The Field Of Being Is Much Faster Than The Field Of

Objects Investigated By The Natural Sciences, It Parts Way With The Thesis That The Domain Of Being Is Exhausted By The Domain Of Natural Objects. However, The General Form of Bhaskar's Argument Holds for Our Realist Purposes. A Transcendental Argument Seeks To Elucidate The Conditions Under Which Certain Acknowledged Practices And Forms Of Cognition Are Possible. Kant, For Example, Asked What Must Be The Case For Mathematical Judgments To Be Possible. How Is It Both That We Are Able To Extend Our Knowledge, As If By Magic, Through Mathematical Judgments And, More Significantly, That These Judgments Are Able To Provide Genuine Knowledge Of The World Despite The Fact That These Forms Of Reasoning Are Not Based On Experience? Part of Kant's Argument Consisted in Claiming That Mind Imposes the Forms of Space and Time on the Data of Experience. In Other Words, Space And Time Are Not Attributes Of Being Itself But Rather Of The Mind That Regards Being. Insofar, Kant Argues, As Mathematics Is Ultimately A Rumination On The Nature Of Space And Time Taken In Their Most Abstract Form And Insofar As The Mind Imposes Space And Time On The Manifold Of Sensation, It Thus Follows That A Priori Judgments About The Nature Of Spatio-Temporal Relations Are Possible That Anticipate The Structure Of Actual-Space Times Without Directly Experiencing These Space-Times. Why? Because Any Manifold Of Sensation Must Necessarily Be Structured By These Forms Imposed By Intuition Onticology– A Manifesto For Object-Oriented Ontology Part I Posted By Larval Subjects Under Object-Oriented Philosophy. ………. it is necessary to distinguish the being of objects from the manifestation of objects. While objects are acts, these acts are not identical with their performance in either nature (events where no humans are about to perceive them) or with their performance for humans. Rather, the proper being of the object is not its performance or manifestation, but the generative mechanism that serves as the condition under which these performances or manifestations are possible. As Graham Harman will argue– though in a very different theoretical constellation –the being of objects is essentially withdrawn or hidden. No one has ever perceived a single object, but we do perceive all sorts of effects of objects. Traditional epistemology has confused these effects with the objects themselves. Fortunately we do occasionally manage to cognize objects through a sort of detective work that infers these generative mechanisms from their effects; without, for all this, ever exhausting the infinity of a single object. At any rate, if objects were not withdrawn in this way, the practice of experiment would be unintelligible. This leads to Bhaskar's answer to the first question: What must the world be like for science to be possible? Note, this is not a question about mind or culture, but about the world itself, regardless of whether or not humans exist. Once again, knowledge is an accident of objects, not objects an accident of consciousness or cognition. If science is to be possible– and I would argue, if any human practice is to be possible –then the world must be structured and differentiated. The world must have joints or, as Harman puts it, the world must be composed of "chunks". Why is this case? Let us return to the question of experimentation and the conditions under which experiment is possible. We will adopt two possible hypotheses pertaining to the ontological nature of the world independent of humans: 1) As certain mystics and contemporary crypto-mystics would have it, the world is an undifferentiated One-All that is only subsequently segmented or partitioned into discrete beings by some form of human agency whether this be through cognition or language (in the case of language we might think of Saussure's and Hjelmslev's undifferentiated "sonorous matter"). 2) Entities are the sum totality of their relations to all other entities in the universe. The first hypothesis is easily dispatched on two grounds: First, this hypothesis fails to register the contradiction in its own utterance. At the level of explicit content, it claims that the world is an undifferentiated One-All that is only subsequently segmented into discrete beings, yet what it misses at the unconscious level of its own utterance is that it registers at least one structured differentiation that is not undifferentiated within this One-All: Namely, the agency through which the One-All subsequently comes to be differentiated. Certain anti-realist, transcendental philosophers will, in a gesture that is all too cute, claim that the agency by which the world is segmented cannot properly be said to exist, thus attempting to resolve this contradiction through a sleight of hand. However, as Meillassoux has shown in After Finitude, all attempts on the part of transcendental anti-realist philosophies to treat the transcendental subject as a non-existing or non-objectile agency that does not itself exist end up, all too clearly, attaching that conception of finitude and the segmentary work with which it is charged to the body (a differentiated being or generative mechanism). Second, suppose the anti-realist transcendental philosophers were to convince us through his appeals to the non-existence of the transcendental, would we still encounter problems? Like Atlas, transcendental subjectivity is charged with the monumental task of segmenting the formless Apeiron of the One-All from out of primal chaos into a supremely segmented world. But this world appears to us to be too slippery for even a titan like Atlas to grasp. Were the world, prior to and independent of humans genuinely a formless Apeiron it would contain no differences providing hand-holds for Atlas to grasp in his segmenting activity. Consequently, no segments could ever come into being. Yet everywhere we encounter segments, so the world must not be a formless One-All, but must rather be structured and differentiated even if structure and differentiation are transformed in their encounter with the human. Onticology– A Manifesto For Object-Oriented Ontology Part I Posted By Larval Subjects Under Object-Oriented Philosophy. The neural networks of the human brain act as very efficient parallel processing computers co-ordinating memory related responses to a multitude of input signals from sensory organs. Information storage, update and appropriate retrieval are controlled at the molecular level by the neuronal cytoskeleton which serves as the internal communication network within neurons. Information flow in the highly ordered parallel networks of the filamentous protein polymers which make up the cytoskeleton may be compared to atmospheric flows which exhibit long-range spatiotemporal correlations, i.e. long-term memory. Such long-range spatiotemporal correlations are ubiquitous to real world dynamical systems and are recently identified as signature of self-organized criticality or chaos. The signatures of self-organized criticality i.e. long-range temporal correlations have recently been identified in the electrical activity of the brain. A recently developed non-deterministic cell dynamical system model for atmospheric flows predicts the observed long-range spatiotemporal correlations as intrinsic to quantum-like mechanics governing flow dynamics. The model visualizes large scale circulations to form as the result of spatial integration of enclosed small scale perturbations with intrinsic two-way ordered energy flow between the scales. Such a concept maybe applied for the collection and integration of a multitude of signals at the cytoskeletal level and manifested in activation of neurons in the macroscale. The cytoskeleton networks inside neurons may be the elementary units of a unified dynamic memory circulation network with intrinsic global response to local stimuli. Cite as: arXiv: chao-dyn/9809003.The neural network of the human brain responds as a unified whole memory bank to a multitude of input signals from the environment and functions with a high degree of robustness and stability. The three aspects of neural networks memory bank are, storage, real-time update and retrieval. The memory is believed to be embedded in the strength of the numerous connections or synapses in the network. Sensory inputs (electrical) produce particular patterns of activity in groups of neurons which then trigger optimal response to the input signal. The cooperative response of millions of neurons to a multitude of input signals has been compared to a very efficient parallel processing computer with neurons and their synaptic connections as fundamental units of information processing, like switches within computers. However, recent studies by Hameroff et al [1,2] and Rasmussen et al [3] show that neurons and synapses are extremely complex and resemble entire computers, rather than switches. The interiors of neurons (and other eucaryotic cells) are now known to contain highly ordered parallel networks of filamentous protein polymers collectively termed the cytoskeleton. Information storage, update and appropriate retrieval are controlled at the molecular level by the neuronal cytoskeleton which serves as the internal communication network within neuron. Organization of information at the molecular level in the cytoskeletal network contributes to the overall response of each neuron and the collective activity pattern of neurons then governs the response to the environmental stimuli. The general awareness or consciousness of the individual to environment may also be governed by the overall background activity pattern of the neurons and their cytoskeletal networks. Coherent signal flow patterns in neural networks may form the basis for general consciousness and response to stimuli (external or internal). Inputs signals trigger spontaneous appropriate coherent pattern formation in the activity of the neurons with implicit spatial correlations in the activity pattern. The time variation of electrical activity of the brain as recorded by the Electro Encephalogram (EEG) exhibits fluctuations on all scales of time, i.e. a broadband spectrum of periodicities (frequencies) contribute to the observed fluctuations [4]. Power spectral analysis which is used to resolve the component frequencies (f) and their intensities shows that the intensity (power) of the component frequencies follows the inverse power law form 1/fB where B is the exponent. Inverse power law form for power spectra of temporal fluctuations imply long-range temporal correlations, i.e. long - term memory of short - term fluctuations. The signatures of short - term fluctuations are carried as internal structures of long - term fluctuations. Time variation of spatial activity pattern in neural networks therefore has inbuilt long - term memory. Neural network activity patterns therefore exhibit long - range spatial and temporal correlations. Such non-local connections in space and time are ubiquitous to time evolution of spatially extended dynamical system in nature and are recently identified as signature of self-organized criticality [5]. Examples of dynamical systems, i.e. systems which change with time include atmospheric flows, electrical activity of the brain, heart rhythms, stock market price fluctuations, etc. Extended dynamical systems in nature have self similar fractal geometry. Self similarity implies that submits of a system resemble the whole in shape. The world fractal coined by Mandelbrot [6] means fractional or broken Euclidean geometry appropriate for description of non-Euclidean structure generic to natural phenomena. The fractal dimension D is given by dlnM/dlnR where M is the mass contained within a distance R from a point within the extended object. A constant value for D implies uniform stretching on logarithmic scale for length scale range R. Objects in nature exhibit multifractal structure, i.e. the fractal dimension D varies with length scale R. Fractal architectures generic to nature support functions which exhibit fluctuations on all time scale, i.e. the fluctuations are irregular (nonlinear) and apparently chaotic. The association of fractal structures with chaotic dynamics has been identified in all dynamical systems in nature. Fractals, chaos and nonlinear dynamics or Chaos Science is now an area of intensive research in all branches of science [7]. Incidentally, Chaos Science began in 1963 with identification of sensitive dependence on initial conditions resulting in chaotic solution for computer realizations of deterministic nonlinear mathematical model of atmospheric flows and named appropriately deterministic chaos .The computed trajectory of time evolution exhibits fractal geometry. The discipline of nonlinear dynamics and chaos began with investigation of universal characteristics of deterministic chaos in nonlinear mathematical models of dynamical systems in all branches of science. In mathematics, the Cantorian fractal space-time is now associated with reference to quantum mechanical objects [8,9,10]. Further, El Naschie has shown that fractal structures (space-time) incorporate the golden mean equal to (1+Ö 5)/2 =1.618 in their architecture signifying ordered signal /information flow in the fractal network. The golden mean is incorporated in the fractal architecture of the cycloskeleton network [11] which plays a very important role in sub-consciousness to consciousness process integration [12,13]. Surprisingly similar chaotic behavior in space and time was found to be exhibited by all real world dynamical systems. Fractal structure to the spatial pattern concomitant with chaotic (irregular) dynamics has now been identified to be intrinsic to physiological and biological systems [14,15]. The branching interconnecting networks of neurons and intra-neuronal cytoskeleton networks are fractal structures which generate electrical signal pattern with self-similar fluctuations on all scales of time characterised by 1/fB power law behavior for the power spectrum. Such inverse power law form for spectra of temporal fluctuations implies long-range temporal correlations, i. e., long term memory of short term fluctuations or events. Fractal architecture of neural networks supports and coordinates information (fluctuations) flow on all time and space time scales in a state of dynamic equilibrium, now identified as self-organized criticality, is ubiquitous to natural phenomena (living and non-living) and is independent of the exact details of the dynamical processes governing the space-time evolution. The physics of self-organized criticality or deterministic chaos is not yet identified. The physical mechanism governing self-organized criticality should be universally applicable to diverse biological, physical, chemical and other dynamical systems. In this paper a universal cell dynamical system model for self-organized criticality applicable to neural networks of the brain is summarised [16, 17, and 18]. This model was originally developed to explain the observed self-organized criticality in atmospheric flows [19, 20, and 21]. Therefore a brief description of the model with respect to atmospheric flows in first described followed by application to neural networks. Atmospheric flows exhibit self-organized criticality or long-range spatiotemporal correlations manifested in the self similar fractal geometry to the global cloud cover pattern concomitant with inverse power law form 1/fB for power spectrum of temporal fluctuations in meteorological variables such as temperature, pressure, etc. documented by Tessier et al [22]. The co-operative existence of fluctuations ranging in size (duration) from the turbulence scale of millimetres (seconds) to the planetary scale of thousands of kilometres (years) contribute to coherent weather pattern in atmospheric flows. Townsend [23] postulated that large eddies (waves) form in atmospheric flows as a chance configuration (envelope) of enclosed turbulent (small scale) eddies. A hierarchical continuum of eddies is therefore generated with larger eddies enclosing smaller eddies. Since large eddy is but the integrated mean of enclosed turbulent eddies, atmospheric eddy energy (kinetic) distribution follows normal distribution characteristics according to the Central Limit Theorem in Statistics. The eddy kinetic energy represented by square of eddy amplitude then represents the probability density. Such a result that the additive amplitudes of eddies, when squared, represent probability densities is observed in the subatomic dynamics of quantum system such as the electron or photon. Atmospheric eddy energy spectrum therefore follows quantum-like mechanical laws [19,20,21]. Condensation of water vapour in updraft regions of large eddies give rise to cloud formation while adjacent downdraft regions are associated with evaporation and cloud dissipation, thereby accounting for the discrete cellular structure to cloud geometry.\ Under the head of applications authors' describe the following: Frohlich [24] had described analogous self-organization of vibrational modes of all frequencies triggering coherent activity in biological functions. Insinna [25] has summarized Froehlich's coherent excitation concept as follows. More than 20 years ago Frohlich [24,26-28] introduced the concept of cooperative vibrational modes between proteins. Coherent oscillations in the range of 1010- 1012 Hz involving cell membranes, DNA and cellular proteins could be generated by interaction between vibrating electric dipoles contained in the proteins as a result of nonlinear properties of the system. Through long-range effects proper to Froehlich's nonlinear electrodynamics a temporospatial link, is, in fact, established between all molecules constituting the system. Single molecules may thus act in a synchronized fashion and can no longer be considered individual. New unexpected features arise from such a dynamic system, reacting as a unified whole entity [25]. Coherent Frohlich oscillations may be associated with the dynamical pattern formation of intraneuronal cytoskeletal architecture which coordinates and integrates information flow into the neuron and generates output signal. Hameroff and colleagues [1,29-31] have simulated such interaction in their cellular automata model. Conclusion they draw in is herein below: Fractal architecture to information flow path results in spatiotemporal integration of signals so that the fractal system responds as a unified whole to a multitude of input signals. Two disparate examples for such self-organized information flow networks are atmospheric flows and the neural networks of the human brain. **Cantorian Fractal Spacetime and Quantum-like Chaos in Neural Networks of the Human Brain A. M. Selvam (for reference s please see the original article. Models are given elsewhere in the papers series .** If The Holographic Principle Is True, Than It Must Be The Fundamental Principle Of Mind. The Brain Has No Way Around The Holographic Principle. For The Reductionist, The Holographic Principle Is The Ultimate Reduction. It Applies To The Most Minuscule Level Of What We Can Observe, And Beyond. For The Universalist, The Holographic Principle Gives Us The Ultimate Universal. It Extends To The Limit Of Our Universe, The Universal Holographic Boundary, And Beyond. For The Phenomenalist, The Holographic Principle Gives Us The Ultimate Ground Of Our Phenomenal Perception, Our Grounding In The Universal "Now," In The Now-Present Of The Universal Holographic Boundary, Moving Outward From Now-Pasts To Now-Futures. Wheeler (1988) Has Said That All Of Reality Is Information, And That Other Physical Quantities Are "Mere Incidentals." Information Monism Is Gaining Popularity In Physics. By Breaking The Dichotomy Of Between Information And Experience, We Find A Deep Connection Between Wheeler Is Monism And The Experiential Monism Of Whitehead, Sometimes Called Panexperientialism, Which Relates To The Later Theological Concept Of His Student, Charles Hartshorne, Panentheism, God Inside Of Everything (Hartshorne, 1964). There Thus Seems To Be A Convergence Of The Concepts Of Information, Experience, And Spirituality. There Is Not One Universe, But Many Parallel Universes, Or, More Accurately, A Vast Superposition Of Universes Called The Multiverse (Penrose, 2004). However, As Explained In Our Treatment Of The Double-Slit Experiment, In The Observation Of Events On The Quantum Level, The Individual Observer Sees Only One Of These Vast Superpositions, Not A Summation Of A Vast Number Of Potentials. This Has Been Explained In Terms Of The Many Worlds Or Many Minds Theories, In Which There Are Multiple Copies Of The Same Observing Individual, But This Particular Issue Remains Unresolved, Leaving Physics Ungrounded In Reality (Penrose, 2004). The Concept Of One Mind Is Not Only More Parsimonious Than That Of Many Minds, But Also Lets Us Out Of The Bizarre And Counterintuitive Idea That There Are Multiple Copies Of Our Own Selves, Which Exist As Mere Potential, And Are Thus Not Actual. There Are Many Possible Universes, But There Is Only One Mind, Which Determines Events On The Quantum Level, And Thus Creates Our Universe. As We Had Discussed Previously, The Quantum Level Provides The Essential Ground Of The Holographic Principle, Such That Quantum-Level Holographic Surfaces Are Elaborated At Higher Levels, Manifesting Higher Orders Of Information From The Quantum "World." In This Process, There Is A Reduction Of The Wave Function Or Potentialities Of Quantum Fields. At The Level Of Consciousness, This Entails Freedom To Choose Which Observations We Make (Stapp, 1997), Which Gives Us The Capacity To Think And To Make Decisions. These Capacities Are The Basis Of Individuality, Self-Determination, Judgment, And Values. The Progressive Evolution Of The Manifestation Of Mind Through Higher Orders Of Experience, Leading To Higher Orders Of Consciousness, Is Entailed By The Holographic Principle. Again, We Are Dealing Here With Levels Of Description, With The Multiverse Of All Potentials Fundamentally Supporting The Single Universe We Collectively Observe. The Multiverse Is The Wave Function Of The Universe (Penrose, 2004). The Recursive Integration Of Nested Hierarchies Of Holographic Surfaces Brings Out A Single Actuality In Consciousness From A Wave Function That Is Unconscious. Consciousness Thus Gives Us Information At A Level Of Experience That Is Causal. In This Sense, We Partake In The Creation Of The Universe. We Participate In Creation, And This Participation, When Fully Realized, Leads Us To Higher Levels Of Consciousness And Of Realization. As A System, The Biosphere That We Live In Has A Holographic Surface, Creating A Deep Sense Of Ecology As We Collectively Move Toward A Planetary Consciousness. It Is Only When The Universal Holographic Boundary Reaches The Information Storage And Processing Capacity Needed For The Requisite Biological And Biochemical Complexity That Consciousness Evolves In Living Things. This Evolution Is Natural And Spontaneous, Since Consciousness Gives Rise To What Is Actual, As Opposed To What Is Merely Potential. In This Sense, Consciousness Is Still In The Process Of Creating Our Universe, And Levels Of Higher Consciousness Will Continue To Evolve. We Are All In The Same "Now," And That Now Is Defined By The Present Universal Boundary. This Assures Us That Our Experience Is Universal, And Does Not Pass With Time. This Is The Fundamental Basis Of Memory And Of Cognition. The Identity Of Mind And Brain Is A Myth. We Have A Continual, Internal Or Non-Local Relation With The Universe, As It Has With Us. Once This Mystery Is Resolved, The Myth Is No Longer Needed, And There Is A Confluence Of Science And Spirituality.Experience Is Primary, Information Is Secondary. We Can Only Gather Information From Experience, Whether It Is In The Laboratory Or In Life. We Cannot Measure The Information On The Surfaces Of Systems. The Physicists That Have Formulated The Holographic Principle For All Systems Are Quite Aware Of This, Or Else The Principle Would Have Been Established Or Discredited. We Cannot Measure What We Experience. It Is Intangible, Yet It Is All We Know To Be Actual. Everything Else Is Inferred. Because It Cannot Be Measured, It Has Been Fundamentally Disregarded By Mainstream Science. Materialism Is Considered Scientific, While Idealism Is Considered Unscientific. But Aren't Ideas, Fundamentally, Made Of Information? Brain Science Has Mistaken The Representation Of Information For Information Itself, And Has Tied Those Representations To Matter And Energy. Consciousness, The Highest Order Of Information, Has Generally Been Regarded As Superfluous, Something That Needs To Explained Away, Or Altogether Ignored. Yet It Is The Only "Thing" That Reaches Our Awareness. Consciousness Comes At A Price. For Everything That Becomes Conscious, There Must Be Something That Becomes Conscious. Consciousness Is Certainty, And Its Complement, Unconsciousness Uncertainty. Consciousness Is The Particle Nature Of Experience. It Has Definiteness About It. The Unconscious Is The Wave Nature Of Experience, It Is Like The Metaphysical Cloud Of Unknowing. If We Are The Most Conscious Of Animals, Then We Must Also Be The Most Unconscious. Perhaps This Is The Predicament Of Humankind. The Holographic Principle Of Mind Leads Us Naturally From The Most Fundamental Experiences, Existing As Quantum Potentials From The Conformations Of Proteins Down Through The Fields Of Electrons, Through Their Manifestation Upward Through A Recursion Or Successive Applications Of The Same Holographic Process, Through Higher Levels Of Experience, To The Emergence Of Consciousness As Higher And Higher Orders Of Experience. The Quantum Holographic Principle Mind Does Not Require Anything More Quantum Than Is Obviously Present At The Microscopic And Submicroscopic Levels, As It Represents Successive Orders Of Manifestations From These Levels. Recursion Also Applies Here In The Sense That It Is Used In Computer Science, In Which The Function Of The Part Depends On The Function Of The Whole. A Program, As A Part, Cannot Work Without A Functioning Whole, The Operating System Recursive Wholes Which Are, For Us, Supra-

Conscious, Are On The Group, Species, Planetary, And Universal Levels. As Individuals, Our Consciousness Cannot Function Without Recursion To The Universal Consciousness, Even Though We May Be Unaware That Such Universal Consciousness Exists. Reaching Upward To These Supra-Conscious Levels Is A Spiritual Process, Making Transcendence The Ultimate Solution To The Unconscious Human Predicament. What Was Once Supra-Conscious Becomes Unconscious Through A Process Of Conditioning? We Are Born As Creatures Of The Earth And Of The Universe, As Evidenced By The Beliefs And Practices Of "Primitive Peoples." There Is Evidence From Cave Paintings That Our Hominid Ancestors Experienced A Kind Of Holographic Perception (Combs, 1996), Which Could Constitute Our Early Connection With The Holographic Subtext Of Reality, And Which We Might Then Propose Existed In Our Animal Ancestors, And In Extant Animal Species. If This Is The Case, Than Microgenesis Would Entail The Recapitulation Of This Holographic Experience As It Progresses Through Our Ancestral Past. The Supra-Conscious Mind Seems To Envelope Perinatal Experiences, And Stanislav Grof (1994) Has Developed Techniques To Gain Access To These Experiences, As Well As To The Earlier Experiences Of Our Human And Animal Ancestral Lineage, And Of Our Universal History. Grof (1994) Concludes: "Our Consciousness Seems To Have The Amazing Capacity To Directly Access The Earliest History Of The Universe Ñ Witnessing Dramatic Sequences Of The Big Bang, The Formation Of The Galaxies, The Birth Of The Solar System, And The Early Geophysical Processes On This Planet Billions Of Years Ago." The Holographic Principle Theory Of Mind MARK GERMINE Institute For Psycho Science There Are Similarities Between The Patterns Of Holography And Of Psychological Transference, Where Holography Is The Process Of Recording And Reconstructing Holograms Employing A Theoretical Perspective Using A Hermeneutic Method, This Dissertation Parallels Holography With Transference, Offering Another Way To Encounter Transference By Showing Similarities Between The Processes Of Each And The Results Of Each. Though Complex, Infinitely Varying, And Unique, Their Patterns Are Clearly Identifiable. Thus They Are A Metaphorical Fit To The Concept Of Strange Attractors In Physics And A More Literal Fit To The Concept Of Archetypes In Depth Psychology Or Dynamic Psychology, Psychology Which Attends To The Living, Autonomous Unconscious. This Study Explains How Holography Models Transference, What A Hologram Is And How It Works, And How Depth Psychology Understands Of The Interaction Between Consciousness And The Unconscious Is Related To The Hologram. It Describes Transference And Related Psychological Processes As Understood In Six Different Schools Of Depth Psychological Thought. It Shows That The Underlying Pattern Or Strange Attraction Between Transference And Holography Extends To Other Processes Both Within And Outside The Field Of Psychology, Processes Such As Projection, Projective Identification, Splitting, Memory, Biology, Creative Discovery, Theology, Synchronicity, Chaos, And Nonlocality. By Identifying The Similar Patterns Of These Processes, This Study Demonstrates The Existence Of An Underlying Holographic Archetype In Which Essential Qualities Of The Whole Are Present In Each Of The Parts Of The Whole: The Visual Image Of The Overall Hologram Is Present In Each Component Part Of The Hologram, The Autonomy Of The Overall Human Is Present In Each Conscious And Unconscious Component Part Of The Human Psyche. By Noting Differences As Well As Similarities In These Processes, It Suggests An Inventory Of The Qualities Of The Holographic Archetype. This Study Furthers Understanding Of The Pervasiveness, Force, And Autonomy Of The Unconscious Acting Through Transference And Projection By Identifying A Group Projection Of Domestic Violence Lying At The Core Of The Christian Myth. This Study Also Furthers Understanding Of The Concept Of Transference By Providing A Reflection Hologram Of The Human Psyche As An Artistic Work And As A Visual Metaphor Of Transference. **Strange Attractors: Transference, Holography, And An Archetype Burke, J. (2003). Strange Attractors: Transference, Holography, And An Archetype (Doctoral Dissertation, Pacifica Graduate Institute, 2003).** A host of observed, but very basic human phenomena, including consciousness itself,have eluded rigorous scientific description by all disciplines of science. This is true, not because of insufficient evidence for a particular phenomenon's existence, but rather forlack of a theoretical construct, which could fit within the prevailing paradigms of science. For the past century eminent men and women of science have accumulated thousands of pages of data on mind/mind and mind/matter interactions. Many of the most telling experiments have been criticized, perfected and repeated numerous times during the past five decades, using increasingly sophisticated technologies. Meta analysis of these experiments produce accumulated probabilities against chance occurrences exceeding trillions to one (Radin, 1997). It has required, however, that quantum science mature for seventy-five years and during that period, test, validate and synthesize a number of seemingly outrageous physical concepts arising from quantum theory, before testable theories could arise which offer hope that anomalous mind and consciousness data can be explained (Mitchell, 1996).The missing concepts that prevented the earliest investigators of consciousness from succeeding in their quest were 1) a generalized theory of information, and 2) quantum science itself, with the associated phenomena of non-locality, the zero point energy field and the quantum hologram. These associated phenomena are still not well understood butare sufficiently validated today by both theory and experiment to provide a basis for postulating a necessary condition for the existence of consciousness phenomena, as experienced in the observable four dimensional space/time universes. A third concept, chaos theory, is also necessary to understand the nonlinear evolutionary processes that caused consciousness to evolve toward the anthropic consciousness experienced by humans. In particular, chaos theory maps far from equilibrium systems and demonstrates the irreversibility of nonlinear processes and thus the irreversibility of time in the macro-scale universe. Another class of phenomena, including normal sensory perception and evolution, to cite but two, have explanatory theories in classical science, but which in view of current developments in late quantum physics and in chaos theory may be incomplete approximations to the correct theory. Information concepts have been examined by Weiner, von Neuman and Shannon in well-known seminal works and by Frieden more recently (1998) to produce theories useful to physics, to computation and to communications technologies. These theories, although accurate and mathematically useful in their domains, fall short of being sufficiently encompassing when considering the problem of consciousness, its evolution and its associated phenomena. Even relatively simple perceptual organisms utilize patterns of energy, that is, information, not completely described by existing mathematical theories. Theory and experimental evidence for the zero point energy field has been published by many authors, but I shall cite Haisch, Rueda and Puthoff, (1997, 1998), as the most contemporary and relevant work for this paper. Theory and experimental evidence concerning the quantum hologram has been developed by Schempp (1992, 1993) andMarcer (1996, 1997, 1998), separately and jointly, based upon a new understanding ofquantum mechanics. (See previous work by Cramer [1986], Berry [1988], Anandan [1992] and Resta [1997]).Non-locality, although predicted by the earliest work in quantum theory and decisively demonstrated by Aspect in 1982, has been thought to be a curious property of particle physics but of little relevance to macro-scale reality until discovery of the quantum hologram. Further, it is widely believed that non-local quantum information represented by entanglement of particles could not be recovered locally as useable information (Eberhard's theorem). However recent work both in theory and experiment (e.g. see Nature, 1997, 11th December, vol. 390, Sudbury T pp551-552, and Bouwmeester D. et alp 575-579) is in line with the work by Berry, Resta, Schempp and Marcer and makes it clear that this is not the general case for quantum information processing andcommunication.It has been widely accepted in science, until recently, particularly in the field of artificialintelligence, that the brain was likely a complex classical computer, incapable of supporting quantum processes. The work by Hammeroff (1994) and Penrose in isolating and describing microtubules in brain tissue have caused a re-examination of this dogma, and renewed interest in uncovering the quantum processes involved.Based upon this earlier work I postulate and examine the evidence in this paper for thefollowing theories: 1. The basis of subjective experience is rooted in the quantum attribute of naturecalled non-locality. I will use the word "perception" in its most generic sense to denote a basic subjective experience at all levels of complex matter. Thus the non-local quantum correlation between entangled quantum particles is considered the root cause of the phenomenon experienced as perception in more complex matter, but the non-local quantum hologram is the non-local carrier of information for molecular and larger scale matter. Thus, perception is not an object but rather the label for a nonlinear process involving an object, a percipient and information.2. The experience of humans is that they sometimes, perhaps often, perceive information from or about physical objects that is not available through normal, local, sensory mechanisms, nor classical space/time information. Objective testing data in overwhelming abundance provides evidence that this is true, though an explanatory mechanism has until contemporary times remained elusive. I shall call this intuitive information or intuitive perception. I postulate that a quantum hologram is the source of this intuitive perception and that the percipient is at that time in phase-conjugate-adaptive-resonance (pcar) with the entity or object associated with the quantum hologram.3. The phenomenon of "learning" in humans is a subjective process that involves perception, memory, intentionality, and evaluation of outcome and behavior change. This may be viewed as a classical nonlinear feedback loop. Although we cannot know precisely the subjective experience of another entity, presumably in the successful training of animals, an analogous subjective process is in effect. Sheldrake (1981) has published a successful theory of morphic resonance related to animal learning based upon non-local information. Marcer has published papers (1996, 1997) theorizing a mechanism by which the quantum hologram causes learning to take place in both DNA molecules and prokaryote cells as an adaptation process of environmental resonance, rather than mutation and adaptation solely by random processes. I postulate that Marcer's concept can be generalized to nature alarge and that the quantum hologram is the information structure suitable to explain Sheldrake's morphic resonance. The non-local quantum correlations observed in particles, and the non-local quantum hologram associated with molecular and larger scale objects, serve the purpose of providing information at all scale sizes to guide evolutionary processes. That is to say, that quantum non-locality is the basis of perception, and thus fundamental and necessary to the complex organizations of matter and information in the universe. Further, since learning is an observed property of complex systems such as animals and, via the quantum hologram, is theorized to be a property of simple cells and molecules, one can also postulate the generalization that nature evolves through a learning process rather than because of random mutations.4. Marcer (1997) has proposed that the condition of phase-conjugate-adaptive-resonance (pcar) is a necessary condition for an object in three-dimensional reality to be perceived as it really is. That is, resonance requires a virtual path mathematically equal but opposite to the incoming sensory information about the object. Further, that it is the incoming electromagnetic (space/time) information (visual, acoustic, etc), which decodes the information of the quantum hologram and establishes the condition of pcar so that accurate three-dimensional perception is possible. That is to say, both quantum information and space/time information aroused in the act of perception by organisms having sensory preceptors. I propose that the two equal but opposite paths required by the pcar condition are the mathematical equivalent of perception and attention (or intention). (I shall distinguish between attention and intention in following pages.) Discussion The anecdotal evidence for humans perceiving non-local information dates to prehistory. The data were sufficiently robust that both experiences and philosophers, from Plato and Aristotle forward, accepted that both physical and non-physical realms of reality must exist. Non-physical was thought to explain the subtle, ephemeral and mystical subjective experiences ubiquitously reported in human culture. After Descartes and Newton, however, classical western science rapidly discarded the non-physical hypothesis and systematically began to ignore all evidence for perception of non-local information Field theories and point particles were created to preserve the concept of physical contact between particles and to explain obvious examples of "spooky action at a distance" such as gravitation and electromagnetic interactions. Information, broadly defined as patterns of energy, reemerges however, in non-local form in the mysterious quantum spin correlations of double slit experiments, although it has been widely believed that such non-local information could not be recovered and utilized by sensory systems. With validation of theory and experiments concerned with the non-local quantum hologram, information, including non-local information, suddenly acquires a more important status in physical theory, a status as important as energy itself. This is true because information is the basis of the cognition and knowing by which creatures perceive reality, and non-local information can now be seen as a ubiquitous and useful property of the cosmos, rather than a unique attribute of particles (and human animals). It is likely that most, if not all, subtle, ephemeral and unexplained phenomena associated with subjective experience are connected, directly or indirectly, with the phenomenon of non-locality. The brain is clearly a quantum computer (Schempp & Marcer, 1996) which utilizes both quantum and space/time information. This discovery alone almost certainly sets a necessary, but not sufficient condition, for intelligent life to have arisen in the cosmos, wherever environmental conditions permit. Many volumes have been written in this century by scientists experimenting with remote viewing, ESP, telepathy, clairvoyance, precognition, etc. Police agencies routinely use "psychics" to assist in criminal cases often with success. Intelligence agencies of governments have clandestinely utilized the findings to successfully gain information about an adversary. Many reports of these activities have been recently declassified and printed in open professional journals, even though no explanatory physical mechanism has yet been reported which is acceptable to mainstream science. The most succinct modern summary of this activity and analysis of results have been published by Radin (1997). Quantum Holography Non-locality and the non-local quantum hologram provide the only testable mechanism discovered to date which offer a possible solution to the host of enigmatic observations and data associated with consciousness and such consciousness phenomena. Schempp (1992) has successfully validated the concept of recovery and utilization of non-local quantum information in the case of functional Magnetic Resonance Imaging (fMRI) using quantum holography. Marcer (1995) has made compelling arguments that a number of other chemical and electromagnetic processes in common use have a deeper quantum explanation that is not revealed by the classical interpretation of these processes. Hammeroff (1994) and Penrose have presented experimental data on microtubules in the brain supporting quantum processes. The absorption/re-emission phenomena associated with all matter is well recognized. That such re-emissions are sufficiently coherent to be considered a source of information about the object is due to the theoretical and experimental work of Schempp and Marcer, based upon the transactional interpretation of quantum mechanics of Cramer (1986), the Berry geometric phase analysis of information (Berry, 1988; Anandan, 1992) and the ability of quantum phase information to be recovered and utilized (Resta, 1997). The mathematical formalism appropriate to these analyses is consistent with standard quantum mechanical formalism and is defined by means of the harmonic analysis on the Heisenberg nilpotent Lie group G, algebra g and nilmanifold (see Schempp (1986) for a full mathematical treatment). The information carried by a quantum hologram encodes the complete event history of the object with respect to its three dimensional environment. It evolves overtime to provide an encoded non-local record of the "experience" of the object in the four-dimensional space/time of the object as to its journey in space/time and the quantum states visited. The question of the brain's ability, as a massively parallel quantum processor, to decode this information is addressed by Marcer and Schempp in "Model of the Neuron Working by Quantum Holography" (1997) and "The Brain as a Conscious System" (1998). They argue that an organism's ability to perceive objects as they are and where they actually are in three-dimensional reality requires the phase conjugate relationship provided by quantum holography. It is not sufficient for the incoming electromagnetic illumination (or acoustic signal) carrying object information to present tothe brain a wave front in the manner presented to a flat photographic plate. Rather, a virtual signal as mapped by the phase conjugation of quantum holographic formalism is required to decode the information in order for perception and cognition to exist as we experience it in three dimensional realities. The percipient and the source of information are in a resonant relationship for the information to be accurately perceived. Many investigators have proposed a holography mechanism as a basis for brain functioning, beginning with Pribram, and indeed, others have proposed holography as a construct forth universe itself, but discovery of the non-local quantum hologram created by the absorption/remission phenomenon and characteristic of all physical objects provides the first quantum physical mechanism compatible with macro-scale three dimensional worlds we experience it. The existence of a quantum hologram associated with each physical object provides each physical object with the non-local waveform predicted by quantum theory's wave/particle duality and extends quantum theory to all physical matter. It allows, for the first time, possible approach for understanding the mysterious world of consciousness. Postulating that this is globally true, we inhabit a quantum world where non-local effects should be expected at all levels of functioning, not just as a curious artifact of the subatomic level of reality. Existence of the non-local quantum hologram suggests that nature has utilized non-local information from the big bang forward, throughout its evolutionary history; and long before planetary environments self organized to permit living matter and complex space/time sensory systems to evolve. The papers of Marcer and Schempp on learning inherent in DNA and prokaryote cells using quantum holography, when generalized, helps explain the ubiquitous appearance in nature across distances, scale sizes and species, of similar processes, organs and sensory systems. This certainly conforms to the fractal geometry of chaos theory. Certainly the similarities, of DNA, cell structure, organs and brains across species are easier to reconcile with a non-local learning process than with a theory of localized random mutation and natural adaptation. It is important to observe that in standard particle physics experiments the object is to discover the quantum characteristics of the individual types of particles, and the conditions under which they split and recombine. In quantum holography the object is to treat the entire group of re-emitted quanta as a whole, and as in laser holography, to examine the information carried in the interference pattern and phase relationships. These represent two quite different levels of approach to quantum information. In particle experiments, it is considered that the eigenvalues of the applicable matrix represent measurable values; and that information is lost during measurement due to decoherence of the particles and energy exchange. But in the quantum holographic formalism, the information is carried in the phase relationships, which are represented by off-diagonal terms in the matrix, and the information is recoverable under the proper conditions as Berry and Resta have predicted, and as Schempp has demonstrated with fMRI. The quantum mathematics is consistent with standard quantum theory in both cases. In decoding the quantum holographic information, however, the energy exchange is insignificant. The similarity of the mathematical treatment in these various experiments is important tothe thesis of this paper. In examining the quantum non-locality of particles it is spin numbers and/or polarization that are the parameters of interest. A standard technique of analysis is to use the Fourier transform to map the state of the particles into the frequency domain. In the formalism of the quantum hologram, mapping into the frequency domain is also fundamental; however, the requirement for pcar assures that the phase relationships are matched so that the percipient (sensory system) is able to decode the information carried in the phase relationships. It is precisely the pcar requirement that permits the encoded holographic information to be decoded by the percipient. Mathematically, decoding is simply reversing the rotation of the phase vector in phase space. Physically, it is matching the frequencies and phase of the information such that resonance results. Frequency, phase matching and resonance are an operational characteristic of every type receiver technology. Pribram's earliest proposal that the brain stored information encoded as in a hologram and mapped by the Fourier transform is in complete agreement with the evidence presented by quantum holographic mathematical formalism. It is the spin and polarization attributes of particles (both are mapped by wave mathematics) that represent the puzzling non-local property of subatomic matter. It is the phase relationships that carry the information in holography (again mapped by waveform mathematics). And it appears that the brain stores and manages information not as a classical digital machine, but rather as an analog device using non-local properties of thequantum hologram, which can be analyzed by wave form mathematics (harmonic analysis on the Heisenberg Lie group). In the cosmological evolutionary scheme of things this similarity of appropriate mapping techniques is too bizarre a coincidence to be ignored Asa cosmic accident. Thus there is ample evidence that the **non-local attribute of** nature is much more than just a curious artifact of subatomic particle interactions, but rather is a more fundamental phenomenon that appears at all scale sizes and is, in particular, associated with the utilization of information in nature, and associated with the fact that information has a causal effect independent of distance. It is precisely information, however, that is the basis of the phenomena of perception, cognition, memory, learning etc, that is to say, consciousness and the subjective experience. Though the evidence is quite ample to postulate that non-locality is the unique, universal basis for perception and the subjective experience, the evidence though compelling is not sufficient to be conclusive that such is indeed the case. The next steps are to validate more completely with experimental evidence that non-locality plays a major role at all scale sizes and that all physical objects are quantum objects and thus interconnected by information in this strange way. **Non-Locality in Nature**: There is experimental evidence to strongly suggest that simple organisms perceive and respond to information non-locally as well. Cleve Backster was perhaps the earliest to experiment with plants and simple life forms in electromagnetic isolation in late 1960'sand early 1970's. His work was not confirmed through replication by others at that time. Other investigators have had mixed results replicating non-local information perception by simple organisms and living tissues. In the area of human experimentation, results likewise have been mixed and controversial for three-quarters of a century. However Meta analysis by Radin (1997) and independently by Utts (1991) across a large and appropriate spectrum of experiments demonstrates compelling statistics that the **perception of non-local information exists and is real.** Perhaps was there a larger body of experimental evidence for simple life forms, similar Meta patterns would emerge. Failure to replicate results in well constructed experiments does not, in the case of subtle consciousness phenomena, prove that the phenomenon is missing but rather that a **hidden mechanism** below the threshold of classical measurement is operating. For example, the most telling experimental evidence to explain the sometimes inconsistent results relates to direct non-local observer and/or experimenter effects. Gertrude Schmiedler isolated the **"sheep/goat "**effect in human experimentation decades ago (1972). Experimenters and/or participants in a human telepathy (or similar non-local) experiments exhibited results statistically above or below chance results depending upon their subjective bias toward the experiment. (In other words, 100% wrong answers would be as statistically significant as 100% correct answers in such tests, and in addition betrays the mind set or intention of the subject; whereas only chance results would be inconclusive.) More recently, a series of experiments by Marilyn Schlitz (1997) investigating "intentionality" clearly demonstrated that experimenter bias (intentionality) affected the outcome even of double blind experiments. Thus, in the subtle realms of mind and consciousness studies, bias, belief and intention clearly have an effect. The lack of an existing theoretical structure in classical science to support any type perception of non-local information, much less to support bias, belief or intention as having a non-local effect, when in fact it does have a non-local effect, is quite sufficient to account for anomalous results in many scientific experiments. Further validation and acceptance of the non-local thesis will have strong positive repercussions for the prevailing scientific paradigm and particularly the theory of measurement. **Attention and Intention:** A powerful and telling series of experiments conducted by Dean Radin (1997) at University of Nevada at Las Vegas following a decade long set of equally significant experiments by Brenda Dunne and Robert Jahn at Princeton University (1988) provide insight as to the subtleties involved in this level of mind/brain functioning. Jahn and Dunne provided overwhelming evidence that subjects could intentionally produce statistically skewed results in mechanical processes normally thought to be driven by random processes. Radin went further; he discovered that audiences watching a stage performance would skew the output of nearby random number generators during periods of high emotional content in the stage performance. Further, in a wide-ranging audience participation experiment, he recorded the output of computer random number generators during the television broadcasts of the O.J. Simpson murder trial. Most television media reported this event for weeks on end and tens of millions of humans were watching the results. Again, the results of the random number generators were skewed corresponding to emotional peaks during the trial drama and corresponding to the number of people watching television. The thesis in the Princeton experiments was that participant intentionality created a non-random effect to bias the skewed distribution. In the Radin experiments the results were not intentional, as the participants were unaware of the experiment, but the hypothesis was that attention (in particular, rapt attention) drove the system away from chaos (randomness) and toward greater order (reduced entropy). These results suggest that attention and intention provide closely correlated outcomes, further, that randomness may not be a general property of nature, but that what is perceived as random noise in a system may be information (a pattern of energy) that is not in resonance at that moment with the particular perceptual system. William Tiller, emeritus professor at Stanford also has performed experiments (1997) that are consistent with these results, though his interpretation of the operating mechanism is somewhat different. These different types of mind/mind, mind/matter experiments have been rigorously and routinely conducted for decades with statistically compelling results but just as routinely dismissed or ignored by main stream science because the implications of non-local action are so foreign to the classical paradigm. However, if we consider that the condition of phase-conjugate-adaptive-resonance is necessary to completely specify the act of perception as described in the mathematical formalism of the non-local quantum hologram by Marcer, then we may also consider the perceived object and the percipient's perceptual system as locked in a resonant feedback loop. The incoming wave front carrying information may be labeled as "perception" from the point of view of the percipient, and the return path required by the resonant relationship may be labeled "attention" (or for subsequent discussion, "intention"). It is a well established principle in the meditative practices of esoteric disciplines that prolonged focused attention on a object of meditation causes the percipient and the object to appear to merge so that a deeper level of information about the object is obtained; information such as history or internal functioning, that would not be available through classical space/time information. The concept of the quantum hologram adequately and completely describes how this phenomenon might take place. Further, it is accepted that the mind/brain is a massively parallel processor, capable of performing many tasks simultaneously and subconsciously (in the right, intuitive part of the brain). Attention (meaning conscious, focused attention) is a unique and singular task that must take place sequentially, mostly in the left cognitive part of the brain. The condition of attention deficit disorder (ADD) is precisely the problem of a percipient being unable to maintain a singular focus for sufficient time to complete a desired task or observation. Thus, the action of focusing attention by apercipient may be construed as a necessary condition for pcar to be established with the perceived object. Non-Locality, Near and Far Marcer has presented the case for the pcar requirement in normal sensory perception (visual and acoustic). A frequent modality used by psychic sensitive individuals to gain information is to physically touch an object. Touching an object satisfies the pcar requirement and presumably allows the percipient access to information about the object not available from space/time information. Police agencies frequently use this modality with psychic sensitives to gain information about a crime scene, much as they utilize bloodhound to track the scent of an individual, often with considerable success. If, as in the theory of the quantum hologram, the object has been in the presence of the individual about whom information is desired, the event history of the object and that of the individual intersect. The Berry phase information of the object contains its journey in three dimensional space and time, as well as the quantum states through which it has passed on this journey. The sensitive individual, with a honed talent, seems often able to decode useful Berry phase information from the object about the individual sought. It may also be the case with the blood hound, which additional non-local information has been gained about the subject, even though the classical explanation is that the animal is operating only with heightened olfactory sensing. Although perception in the three dimensional world requires and utilizes pcar, most humans, however, do not bring to conscious awareness non-local information when weare routinely operating in three-dimensional reality. We perceive objects as presented by space/time information, that is, shape, color, function (tree, chair, table, etc) but are not usually aware of the additional non-local information. It takes training as provided by many of the esoteric traditions and/or certain naturally sensitive individuals to routinely perceive the non-local holographic information associated with a particular object. There is massive evidence to suggest, however, that the brain has these latter capabilities at birth. Suppression by cultural conditioning in childhood and subsequent lack of practice cause the natural ability for conscious, intuitive perceptions to atrophy. Particularly in western tradition, educational interest has been on the left brain, rational functions rather than right brain, intuitive functions. However, mystic adepts and natural psychics' routinely demonstrate that non-local information is perceptible from physical objects by focusing attention, quieting the left brain and allowing intuitive perceptions to appear. It is the left brain cognitive ability in humans that provides canonical labeling of the intuitive and artistic processes taking place in the right brain. The fact that with training and practice, individuals can recover, deepen and label their individual cognitive access to intuitive, on-local information demonstrates that learning is taking place within the whole brain itself and involves enhanced coherence and coordination between the hemispheres. This process is different and distinct from the left brain function of extending and extrapolating factual data and logical deduction to leap to an "intuitive" conclusion, while omitting the intermediate steps leading to that conclusion. Experimental protocols for remote viewing normally provide clues to the location of the object such as adescription, a picture, or location by latitude and longitude, that is to say, an icon representing the object. These clues seem to be sufficient for the percipient to establish a resonance with the object. Normal space/time information (visual, acoustic, tactile) about the object is not being directly perceived by the percipient, nor does the object usually appear at its physical location in space/time like a photograph or map in the mind. Rather, the information is perceived and presented as internal information and the percipient must associate the perceptions with his/her internal data base of experience in order to cognize and to describe the object's perceived attributes. In the case of complex objects being remotely viewed, the perceived information is seldom so unambiguous as to be instantly recognizable as correct. Sketches, metaphors and analogies are usually employed to cognize and communicate the non-local information. A considerable amount of training, teamwork and experience are necessary to reliably and correctly extract complex non-local information from a distant location. The information appears to the percipient as sketchy, often dream-like, and wispy, subtle impressions of the remote reality. Very skilled individuals may report the internal information as frequently vivid, clear and unambiguous. The remote viewing information, being strictly non-local, and in this hypothesis, the information perceived by quantumholography, is missing the normal space/time components of information necessary to completely specify the object. It has been demonstrated that this intuitive mode of perception can be trained in most individuals. Perhaps additional training and greater acceptance of this capability will allow percipients to develop greater detail, accuracy and reliability in their skill. In principle, training will not only increase the skill and accuracy but should cause the appropriate neural circuitry to become more robust as well. In the absence of space/time (electromagnetic) signals to establish the pcar condition and to provide a basis for decoding the quantum hologram, an icon representing an object seems to be sufficient to allow the brain to focus on the object and to establish the pcar condition. However, a reference signal is also required to provide decoding of the encoded holographic phase dependent information. Marcer (1998) has established, using Huygen's principle of waves and secondary sources, which any waves reverberating through theuniverse remain coherent with the waves at the source, and are thus sufficient to serve as the reference to decode the holographic information of any quantum hologram emanating from remote locations. The Zero Point Field: The results of the Michelson/Morley experiment banished the concept of aether from early twentieth century physics. However, it left a void as the nature of interstellar space and nothing for propagating waves to wave in. Quantum physics reincarnated the aether as the zero point fields, a seething cauldron of quantum potential and unmanifest energy where particles and antiparticles spontaneously arise and then disappear. The very fabricant structure of space/time itself is again in question; its structure and its metric under intense investigation with far more questions than answers having emerged to date. For the purposes of this paper the relevant issues are two: 1) the emission/absorption phenomenon, and 2) the structure and mechanics of non-locality. Zero point (zero degrees Kelvin) emission and absorption of quanta from all physical objects is a well established phenomenon. It is our view that the zero point fields are the plenum (or cauldron) which supports this absorption and re-emission, and makes the phenomenon of the quantum hologram possible at all temperatures. Although particle experiments are carried out under rigid conditions of temperature and pressure, Schempps experimental work with the fMRI requires no such constraints. There are deep and difficult questions yet to be answered about how the information of thequantum hologram maintains its integrity and is propagated, about how resonance takes place at extremely large distances. There is considerable evidence that intuitively perceived information is truly non-local. It does not obey the inverse square law for space/time energy propagation; it is time independent and cannot be shielded by electromagnetic shielding. Such characteristics are the mark of non-locality. But understanding the mechanics of non-locality (or a visual picture) is missing from standard models. Some physicists turn to superluminal speed of propagation, others to the zero point as a zero dimension, which is resonant with all parts of the universe simultaneously. The issue of instantaneous communication (or at least superluminal communication) of non-local effects on a cosmic scale remains a problem, even though the phenomenon itself is well validated. Perhaps it is a problem of topology. What shape can the universe have such that one point can be in simultaneous contact with all other points? In this regard it is clear that certain problems between quantum mechanics, special and general relativity remain inexistence. Haisch, Puthoff and Rueda continue to investigate the **metrics of the zero point fields** with regard to better defining the unanswered questions about, mass, gravitation and inertia. Perhaps these investigations will also bring answers for how phase related information is propagated non-locally, likely within the zero point fields, and thereby unveil the mechanics of the resonance phenomenon. Further, new investigations reported by Van Flandern (1998) on measurements from orbiting Global Positioning System (GPS)clocks indicate the predictions from Lorentzian relativity to be approximately four times more accurate (0.7% opposed to 3%) than predictions of special relativity. If these measurements are further validated, it implies that Lorentzian relativity with a Hubble absolute rest reference frame, an aether (zero point field), and instantaneous propagation of non-local effects may be the preferred one. If this is the case, then many questions about non-locality would be resolved. Intentionality I have argued that by establishing pcar between a percipient and an object, the phase conjugate (equal but opposite) paths connecting the two can be labeled "perception" and "attention". In the case where the object is a simple physical object (rock, flower, etc.), our interest is on the non-local information perceived by the percipient about the object. However, from the point of view of the object, information about the percipient is also available to the object. The pcar condition is a reciprocal relationship, mathematically. Quantum holographic formalism predicts that the history of events of quantum objects is carried in the quantum hologram, thus we must conclude that the **"attention" focused upon the object causes that event to be recorded in that object's quantum hologram.** Although we cannot query the object about its experience perhaps an experiment such as one utilizing the Aharonov-Bohm effect would detect a phase shift in the object's holographic field. (In this discussion I use anthropic labeling as we are discussing human perception. The phenomena however, are rooted in natural (and primitive) non-local physical processes, which are fundamental. The evolved complexities of perception, cognition, etc, associated with a brain obviously, as yet, have no analogous label to describe the experience of simple objects.)Once the pcar condition is established, the percipient can change its mind state with regard to the object. The perceived information can be operated upon by the brain's function so that cognition occurs with respect to the perceived information and meaning assigned. Cognition and meaning require finding a relationship between the perceived informationand the information residing in the percipient's memory. The percipient can then form intent with respect to the object. In such case the path I have labeled "attention" could Figure 1 In self aware animals (those with a brain) cognition, meaning and intent with respect to an object can often be described in simple terms, for example: enemy, fight or flight; food, eat; friend, greet, etc. The non-local component of information, although present and creating effect, is operating below the level of conscious perception in humans and results in "instinctual" subconscious behaviors in all animals. The brain as a massive parallel computer is simultaneously performing numerous tasks to accomplish the desired intention. Classical modelings of this autonomous activity describe it only in terms of classical information and energy flow in the central nervous system and the brain. However, if non-locality is operating at all levels of activity, as this theory suggests, certainly there are resonances involving non-local information operating throughout the body of an organism in parallel with classical space/time functions. Subsequent experimental work will surely uncover these quantum processes where non-local resonance is involved in the functioning of an animal's internal processes. In the case of non-local effects at a distance, outside the body, simple spin correlations of entangled particles is the most basic. The spin coherence is reciprocal. Action on one particle creates an effect on other entangled particles. The non-local information is causal of affects at large distances. It is no less important for macro-scale objects. Sheldrake (1995) proposed and others conducted experiments with dogs whereby the animals correctly anticipated their owners' departure from work to return home. He proposed other successful experiments where rats learning a new maze benefited non-locally from the experience of others that had previously learned the maze, in the total absence of classical space/time information. It is not surprising then, that human's exhibit an even wider range of reactions to non-local information. The evidence suggests that humans can perceive, cognize, and give meaning to non-local information across a range of complexity, from inanimate objects, simple organisms, animals and other humans. The existence of quantum holography provides an adequate informational structure to permit a theory for the observed results. The case is a classic case in phenomenology, where results are repeatedly observed over time that fall outside the prevailing paradigm, and must await new developments in science before an explanation is forthcoming. The results for intentional effects of non-locality should be no more difficult to accept than the results for perception. The pcar relationship implies symmetry, that is, information flows in both directions between object and percipient such that each is object and each is percipient. Only the complexity of the more ordered perceiving system suggests a non-symmetrical relationship. We humans have great difficulty in accepting that thoughts, specifically intentionality, can cause action at a distance. Yet, it has been observed for centuries and in recent decades subjected to scientific scrutiny. Were not prayer to have produced some positive results, religion would have been abandoned centuries ago. That cause was ascribed to supernatural agency rather than non-locality is simply, again, phenomenology needing to wait while science caught up. Modern studies by Dossey (1993), Byrd (1988) plus many others have attempted to document the efficacy of prayer, particularly healing prayer. The results in most cases are very suggestive of non-local effects, and some claim they establish the case for healing prayer. However, the difficulties of controlling all variables in such clinical studies leave many avenues for valid criticism. The fact that Radin's several studies (1997) demonstrated that attention alone produced non-local results in machines, i.e., reduced randomness (increases order) does confirm that information has non-local effect and may be correctly formulated asnegentropy. These results apply directly to healing prayer as well.The case for pcar conditions to create remote effects by transfer of non-local information between equally complex percipients, humans for example, is not difficult to understand. Indeed, hundreds of successful experiments establish the case. In these cases no energy transfer is required, only non-local information, as each percipient/object has access to its own energy source. The case for intentionally creating remote physical effects in inanimate objects is more puzzling. Even though teleportation of quantum states has been successfully accomplished for particles, and numerous studies (Radin, 1997; Dunne and Dunne, 1988) show that macro-scale objects can also be changed or moved, the energy transfer mechanism by which the classical states of a remote object are affected remains elusive. Conclusions The case for mind/mind and mind/matter interactions is impressively well documented over many decades as studies in phenomenology, with staggering probabilities against chance having produced the results. The discovery of the non-local quantum hologram, which is theoretically sound and experimentally validated in at least one application, thé fMRI, is sufficient to postulate that the quantum hologram is a solution to the foregoing enigma. Further, recognition that the quantum hologram is a macro-scale, non-local, information structure described by the standard formalism of quantum mechanics extends quantum mechanics to all physical objects including DNA molecules, organic cells, organs, brains and bodies. The discovery of a solution which seems to resolve so many phenomena, and also that points to the fact that in many instances classical theory is incomplete without including the subtle non-local components involved, suggests a major paradigm change must be forthcoming. The papers already published by Marcer and Schempp proposing a learning model both for DNA and prokaryote cells, which uses quantum holography, suggests that evolution in general is driven by a learning feedback loop with the environment, rather than by random mutations. This solution to biological evolution was proposed by Lamarck in 1809 but discarded for the mechanistic solution of random mutations by the colleagues of Darwin. The fact that non-local correlations and non-local quantum information can now be seen as ubiquitous in nature leads to the conclusions that the **quantum hologram can properly be labeled as "nature’s mind"** and that the intuitive function we label in humans as the “sixth sense" should properly be called the "first sense". The perception of non-local information certainly preceded and helped to shape, through learning feedback, the sensory systems that evolved in planetary environments, and which we currently label as the five normal senses. We must conclude that evolved, complex organisms, which can form intent, can produce and often **do produce non-local causal effects associated with that intent.** Further, that attention alone produces coherence in nature that in some measure reduces randomness. Finally, I conclude that the cited experiments and current understanding of non-locality in nature is sufficient to postulate that **non-locality is the antecedent attribute of energy and matter which permits perception and is the root of the consciousness which manifests in the evolved organisms existing in three dimensional realities**. ReferencesAnandan, J. "The Geometric Phase"; Nature, 360,26, 307-313 (1992)Berry, M. V. "The Geometric Phase" Scientific American, December, 26–32 (1988)Byrd, R. C. "Positive therapeutic effect of intercessory prayer in a coronary care population"Southern Medical Journal 81 (7): 826–829 (1988)Dossey, L. "Healing Words" Harper San Francisco, (1993)Dunne, B. J., Nelson, R. D., and Jahn, R. G. 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Selleri, Apeiron, Montreal (1998) **http://www.cosmicdreaming.com/pdf2011/Nature's%20Mind%20the%20Quantum%20Hologram%20by%20Edgar%20Mitchell,%20Ph_D.pdf**. **Models given in one of the papers. Some sentences are deleted and reformulated for felicity of reading and spatial restrictions. Kindly pardon me on that count. National Institute for Discovery Science: Nature's Mind: the Quantum Hologram by Edgar Mitchell, Ph.D. National Institute for Discovery Science Home > Resources > Consciousness Studies Nature's Mind: the Quantum Hologram Edgar Mitchell, Sc.D. Institute of Noetic Sciences, Sausalito, Calif. Fax: 561-641-5242, edgarmitchell@msn.comIntroduction** My Answer To Quora Question "If Consciousness Has No Evolutionary Advantage, Doesn't That Imply That It Is An Emergent Property? " While Human Consciousness Has Certainly Been Shaped By Evolution, Which Does Not Mean That Consciousness Itself Could Have Evolved From Non-Consciousness. Whether We Are Talking About Other Species Of Animals Or Cells Or Organic Molecules, The Same Issues Which We Run Into In Explaining Human Consciousness Are Still Present At Any Scale. The Issues Of The Hard Problem Of Consciousness, Explanatory Gap, Binding Problem, And Symbol Grounding Problem Make The Mind-Body Split Just As Relevant Wither The 'Body' Is A Brain, Neuron, Or Subatomic Particle. No Matter What, You Have To Explain How An 'Interior World' Can 'Exist' In A Physical Structure Whose Behavior Is Causally Closed. Whatever Way You Slice It, If We Accept That T-Cells Can Be Effective In Detecting And Neutralizing Threats On A Cellular Level Without Having Consciousness, Or That DNA Can Create Cellular Machines Which Build A Brain Without Consciousness, And Then We Are Admitting That Consciousness Doesn't Make Sense As A Functional Adaptation. The Rest Of The Universe Already Works Too Well Without It. There Is Nothing Especially Interesting about A Hominid's Need for Food and Shelter Which Would Demand Rich Awareness to Develop out Of Blind Reflex. Single Celled Organisms Chase Food, Avoid Danger, Etc Also. We Are Then Left With Considering That Either Consciousness Could Somehow Be An Accident Of Evolution, Or That Consciousness May Be Intrinsic To All Physical Phenomena In Some Sense (Panpsychism, Panexperientialism) Or Even That Consciousness Is The Universal Substrate Upon Which All Phenomena Depends (Idealism, Idealist Monism). If Consciousness Is A Mutation That Has No Functional Role (A Spandrel), We Have To Ask Why It Would Even Be A Possibility. Remember That If Consciousness Is A Mutation, We Are Assuming That There Is A Whole Universe Already In Place Which Is Overflowing With Processes, Biological And Otherwise, Which Are Perfectly Capable Of Directing Themselves Effectively While Being Unconscious. It's Actually A Radically Anthropocentric Cosmology Since We Are Privileging Our Tiny Piece Of History In The Universe As The Only Piece Which Is Not Devoid Of Experience. We Are Saying That Everything That Existed Before Humans Was Unconscious, Therefore An Invisible, Intangible, Silent Void With No Memory Etc. If We Are Not Intending That, And Prefer To Think That The Universe Looked, Sounded, Felt, And Tasted Just Like It Does For Homo Sapiens Since The Dawn Of Time, Then We Would Have To Ask Exactly What We Think Consciousness Is Adding To That Kind Of Eternal-Universal 'Unconsciousness'. If Consciousness Is Intrinsic to Physical Phenomena (As in Penrose-Hameroff's Microtubule-Based Quantum Consciousness) or Is Intrinsic to Information Integration (As in Tononi-Koch's IIT), We Still Have the Same Kind Of Mind-Body Problem. A 'Body' Which Is A Statistical Function Rather Than A Literal Form In Space Is Still Falls Short Of Explaining Why And How There Is Any Such Thing As Consciousness. In My View, Only The Idealist Monist View Or What I Call Pansensitivity Makes Sense Ultimately As The Parent Of Both Physics And Information. Just As We Learn To Count On Our Fingers, All Forms Of Information Are Representations Of Experiences Which Have An Aesthetic Foundation – A Seeing, Feeling, Touching, Thinking, Etc. Without That Sensory-Motive Context From The Start, There Would Nothing To

Evolve; Only Abstractions In The Dark (Or Not Even Dark). Once We Can Get Over Ourselves As A Species And Recognize That Consciousness Doesn't Begin And End With Us, I Think That Awareness Will Be Seen As The Container Of Relativity Itself, With Quantum Mechanics And Evolutionary Biology As A Consequence Of Deeper Stories Rather Than Their Originator. Multisense Realism A Cosmology Of Sense, Essence & Existence For Models See One Of The Papers In The Series Procrastinated Due To Constraints On Space. Events Occur In Time, But There Is No Time Except That Which Has Been Produced By The Big Bang. It Makes No Difference Whether The Big Bang Is The Only Beginning Of The Only Universe Or Just The Beginning Of One Of Many Universes, Either Way It Doesn't Explain The Beginning Of Existence. Some Say That Everything Following The Big Bang Is Random, Not Designed, But Why Is 'Designed' Even An Option? If That Word Means Anything, And Anything Has Ever Been Designed By Anything, Then What Difference Does It Make Whether That Capacity Of Intention Came Early On In The Universe Or More Recently? How Do We Know The Difference Between What We Design And What Is Random? How Do We Know That Randomness Even Exists? We Can't Generate True Randomness Computationally, We Can Only Grab Onto Some Pattern That Seems Nearly Random By Some Arbitrary Duration Of Measurement And Say That It Is Good Enough. Random Is A Concept, and the Difference between Random and Intentional May Ultimately A Matter of Perspective. Some Interesting Possibilities Arise When We Consider The Observation That The More Something Seems Intentional, The More It Is 'Like Me' And The More Unlike Me Something Appears, The More It Seems Mechanistic. In A Way That Is Similar To How Any Object Appears As A Dot Or Smudge If It Is Too Small Or Distant For Us To See, The Notion That Perceptual Relativity Dictates The Quality Of Intention And Unintention Is A Provocative Hypothesis Of MSR. Random Events Cannot Follow A Series Nor Have Results. That Doesn't Mean That There Has To Be An Entity Making Everything Happen, But It Suggests That The Universe Is A Phenomenon Of Appearance, And Part Of Appearance Is Oscillation Between Intentional And Unintentional Attributes. The Universe Speaks In Both Entropy And Significance. Randomness Doesn't Do Anything, Can't Be Anywhere Or Feel Anything. Randomness Is An Abstraction Derived From An Expectation Of The Contrary. By Random, All We Mean Is That It Lacks Pattern And Intent – Both Of Which Must Be Implicitly Present Before They Can Be Hypothetically Absent. There Is Sense And There Is Non-Sense, Order And Dis-Order, It Is Not Non-Randomness And Dis-Chaos. Many People Believe That Physical Law Excludes The Possibility Of Free Will Because Of Strong Causal Closure. By This, What Is Meant Is That There Is No Room In Physics For Any Force That Causes A Physical Effect That Has Not Been Accounted For, Whether Or Not This Is Actually True Or Not Is Questionable In The First Place. The Sudden Addition Of Dark Matter And Dark Energy In The 1990s, Which Together Must Account For 95.1% Of Mass-Energy Of The Universe, Doesn't Seem To Have Encountered Nearly As Much Resistance From The Scientific Community Than Conscious Intention Has. Even If It Were The Case, However, And The Typing And Reading Of These Words Will Be Someday Explained By Purely Neurochemical Mechanisms, The Question Of Why The Feeling Of Intention Exists, And How It Can Be Produced Will Remain Unanswered. My Free Will Demands That Your Free Will Admit That There Is No Free Will. In All Of The Contemporary Debates On Free Will There Seems To Be A Blind Spot, In Which Free Will Does Not Exist, Except Where It Concerns The Application Of The Results Of Scientific Experiments. There Is Always A Call For The Educated And Enlightened To Voluntarily Change Their Own Minds, To Be Persuaded By The Argument Of Their Own Free Will. The Hypocrisy Is Hard To Overlook Once You See It. It Seems That The Anti-Free Will Assertion Makes An Exception For People Who Are 'Right'. Being Right Seems To Give Us A Right To Have Opinions Which Others Cannot, Due To Their Enslavement To Physical Causes. An Issue Which Often Comes Up In Free Will Debates Is How Our Stance On Free Will Impacts Criminal Prosecution. Again, The Blind Spot Of The Anti-Free Will Philosopher Projects That While Criminals May Not Be Held Liable For Their Actions Because Their Neurology Is To Blame, Then We Can't Allow Society To Take Credit Or Blame For Its System Of Justice Either. If Guilt Or Innocence Is Irrational, Then Believing That We Can Modify Our Own Attitudes Toward Guilt And Innocence Must Also Be Irrational. What Seems More Irrational Is To Codify Law Into A Mechanistic Formula Which Diminishes Our Capacity For Thought And Feeling In Consideration Of The Fate Of Others (Or Others Considering Our Fate).Zero-Tolerance Determinism: Another Pillar Of The Anti-Free Will Position Is That It Must Be An All-Or-Nothing Phenomenon. This Seems To Be More Of A Hasty Generalization Than An Honest Look At

The Phenomena. In A More Tolerant Analysis, It Should Be Clear That Free Will Doesn't Have To Be Absolutely Free. The Fact That Our Conscious Mind Thinks That It Was Presented With Certain Options Still Requires That We Choose Freely From Among Those Options. It's True That We Are Always, In a Sense, Only Able to Choose What Our Mind Thinks Is the 'Best' Option (Even If That Choice Is Based on Bad Advice from Our Stomach or Emotions), But Still There Is an Intentional Participation Which Cannot Be Explained by Statistical Functions. No Matter How Constrained We Are By The Rules Of The Road, Our Car, The Limits Of Our Driving Skill, Etc, There Is Still A Difference Between Driving And Being Asleep At The Wheel, Or Between Driving And Being Forced To Drive Somewhere At Gunpoint. We Should Not Look Only At How Our Freedom Seems To Vanish Upon Thorough Inspection; We Must Also Look At How It Appears In The First Place – Unbidden And Self-Evident. Look At The Universal Appeal Of Freedom And The Universal Disparagement Of That Which Is Unfeeling, Robotic, And Mechanistic. One Thing That Is Seldom Mentioned In These Endless Debates Is Creativity. Were The Egyptians Destined To Build Pyramids And Not Megalithic Circles? Was It Inevitable That The Star Spangled Banner Was Written In Reference To The United States? Did Deterministic Processes Have No Choice But To Create The Illusion Of Free Will? Why? The Work of Benjamin Libet Is Frequently (Compulsively?) Cited As Well, Work Which Even Libet He Later Made Clear Did Not Show That Free Will Didn't Exist. The Fact That A Neurological Signal Can Be Detected Before The Various Parts Of Us (The Self Who Makes The Decision, The Self Who Knows They Make The Decision, The Self Who Reports That They Make The Decision) Can Arrive At A Consensus Does Not Mean That The Initial Impulse Doesn't Correspond To Conscious Experience. There Is Also The Matter Of Focusing On Repetitive, Reflex Actions Which Minimize Free Will And Maximize Predictive Expectation. These Kinds Of Experiments Are Like Proving That Chefs Lack Imagination By Studying The Fry Cooks At Mcdonalds. Since Physics And Neuroscience Has No Theory At All As To The Origin Or Utility Of Consciousness, We Cannot Give Inanimate Instruments The Benefit Of The Doubt When It Comes To Our Subjectivity. Because We Are A Single Zygote Which Has Reproduced Itself, In Some Sense, Every Cell In Our Body Is 'Us' Just As Much As Any Organ Or Process In Our Body. We Are Complex, But Not In The Way That A Machine Is Complex. We Are Not Assembled From Specialized Parts; We Are A Single Whole, Divided Into Relative Specialization. Just Because Every Part Of Us Doesn't Know What Every Other Part Of Us Is Doing At All Times, Doesn't Mean That It Isn't All 'Us' Doing It Pansensitive Relativity: If The Perceptual Relativity Hypothesis Is Correct, And Pansensitivity Is The Engine Of Both Physics And Subjectivity, Then Cause Itself Is Relativistic. Intention Is Real And Primitively Creative In The First Person, And Unreal/Recombinant-Derivative In The Third Person…But Third Person Is Only Real Because There Is A First Person Participant Present. **Free Will, Determinism, And the Big Bang: Multi Realism Blog: Wikipedia http://multisenserealism.com/2012/08/27/deleuzes-the-logic-of-sense-part-i/.** From A Whiteheadian Perspective, However, There Are At Least Two Key Sources Of Misunderstanding Latent In Some Of These "Returns" To "The Body", "The Object" And "Materiality". There Is A Rather Too Hasty Dismissal Of The Concept Of Subjectivity As Such And There Is A Related Tendency To "Flatten Out" Any Would-Be Distinctions Between Human And Non-Human Entities. Such Positions Thus Risk A Return To A Bleak Anti-Subjectivism That Mocks Those Who Might Cling To The Idea That "Humans Are Very Different From Knives Or Paper" (Harman, 2002, Cited In Thrift, 2008). With Respect To The Latter, For Example, Nigel Thrift Invokes The ANT Principle Of The Democracy Of Things And States That In His Theory "Things [And Human Beings] Are Given Equal Weight, And I Do Mean Equal" (Thrift, 2008, P. 9). Much Of This Is Done In The Name Of A Whiteheadian Inspiration Since The Book Begins With Strong References To Whitehead, Including Key Concepts Such As The "Actual Occasion". The Point Concerning The Dismissal Of Subjectivity Can Be Brought Out Most Starkly By Contrasting One Of Thrift's Statements About His Non-Representational Theory With A Statement From Whitehead Himself. "Thus Things", Writes Thrift, "Are Not Just Bound By Their Brute Efficacy To The Visible Termini Of Humans In Some Form Of Latent Subjectivism Such As 'Concern' Or 'Care'". Now, It Is Certainly True That For Whitehead A "Thing" Is, By Definition, "Describable Without Reference To Its Entertainment" In An Occasion Of Experience (Whitehead, 1933/1935, P. 226). In This Sense, Things Are Not "Bound By Their Brute Efficacy To The Visible Termini Of Humans". But It Is Certainly Problematic To Imply That His Work Is Based Upon A Move Away From The

Subject–Object Relation As The Fundamental Structure Of Experience And Hence From Concepts Such As Concern And Care. On The Contrary, On This Matter Whitehead's Thinking Is Quite Comparable To That Of His Contemporary Martin Heidegger In Being Grounded In The Concept Of Concern. The Centrality Of This Concept Is Due To The Way In Which It Brings Together Subject And Object As Relative Terms In The Unity Of What He Calls An Actual Occasion Of Experience: Thus The Quaker Word "Concern", Divested Of Any Suggestion Of Knowledge, Is More Fitted To Suggest This Fundamental Structure. The Occasion As Subject Has a "Concern" For the Object. And The "Concern" At Once Places The Object As A Component In The Experience Of The Subject, With An Affective Tone Drawn From This Object And Directed Towards It. With This Interpretation, The Subject–Object Relation Is The Fundamental Structure Of Experience. (Whitehead, 1933/1935, P. 226) Granted, Thrift Does State That He Wishes To "Temper… The More Extreme Manifestations Of This Lineage, Which Can End Up By Positing A Continuity Of And To Experience About Which I Am Sceptical" (2008, P. 6) However, One Wonders What Is Left Of Whiteheadian Cosmology If This Radical Extension Of The Concept Of Experience And Hence Of Empiricism Is Omitted. It Is A Little Like Being A Marxist Without The Dialectical Materialism. It Is Also Difficult Not To Be Sceptical About The Remaining Self-Consciously "Inhuman" Theoretical Framework "In Which Individuals Are Generally Understood As Effects Of The Events To Which Their Body Parts (Broadly Understood) Respond And In Which They Participate" (Thrift, 2008, P. 60). In Recent "Radical" Social Theory, It Seems The Baby Of Subjectivity Is At Risk Of Being Thrown Out With The Bathwater Of Representationalism, Leaving Only The Hollow Remainder Of A Reactive Ensemble Of "Body Parts". Some Clarity Is Therefore Needed If We Are Not Simply Going To Recruit Whitehead Into Concerns Alien To His Own. His Chief Problem Was Not the Notion of the Subject/Object Structure of Experience Itself, But It's Too Rapid Identification with the Difference between Knower and Known (Whitehead, 1933/1935, P. 225). It Is This Conflation Of The Deeper Subject/Object Relation With The More Superficial Distinction Between Knower And Known That Gives Rise To A "Representational" Style Of Thinking And Its Interminable Debates. I Will Argue That It Is Precisely By Way Of The Subject/Object Relation Of The Actual Occasion That We Are Best Positioned To Conceive Of "The Cumulation Of The Universe And Not A Stage-Play About It" (Whitehead, 1927–1928/1985, P. 237). **Palgrave Communications | Palgrave Macmillan Journals Journal Home > Archive > Original Articles > Full Text Original Article Subjectivity (2008) 22, 90–109 Doi:10.1057/Sub.2008.4 A.N. Whitehead And Subjectivity Paul Stenner1** 1University Of Brighton, Brighton, UK Correspondence: Paul Stenner, School Of Applied Social Science, University Of Brighton, Falmer Campus, Mayfield House, Brighton BN9 1PH, UK. E-Mail: P.Stenner@Brighton.Ac.Uk (For Models Please See One Of The Papers In The Series Attributed To Spatial Restraints It Is Accommodated Where It Could Be). In Sum, Whitehead Offers A Relational Process Ontology That Promises To Deepen The Constructivist Insights Associated With The Turn To Textuality, But Without Reducing The Universe To "Discourse" And "Materiality". In This Ontology, Things (Whether Occasions Or Assemblages) Are Definable As Their Relevance To Other Things And In Terms Of The Way Other Things Are Relevant To Them. Things Have Relational Essences. Likewise, Things Do Not Exist Independently Of Temporality But Are Constituted By The History Of Their Specific And Situated Encounters. Every Actual Thing Is Thus "Something By Reason Of Its Activity" (Whitehead, 1927/1985, P. 26). Importantly, This Talk Of "Things" Need Not Incline One Towards Denying The Relevance Of Subjectivity. I Have Thus Taken Issue With A Tendency Illustrated In The Work Of Thrift (2008), Who Appears To Define Cutting-Edge Social Theory As Concerned With "Flow" And "Play" Rather Than With Stability (Since "Non-Foundational Theory Takes The Leitmotif Of Movement", P. 5 And "Privileges Play", P. 7); As "A Means Of Going Beyond Constructivism" (P. 5); And As "Trading" In "Modes Of Perception Which Are Not Subject-Based" (P. 7). I Have Tried To Show That, In Fact, The Concept Of Process Is As Much About Stability As About Change. Stability Is To Be Thought Of As An Achievement Resulting From Particular Ways Of Actualizing Potential And Of Patterning Occasions Into Spatial And Temporal Co-Assemblies. Nevertheless, I Have Also Stressed That Becoming Is An Inherently Self-Creative Process, Albeit A Self-Creation Grounded In The Facticity Of A Concrete Inheritance. Whitehead's Category Of Subjective Unity Is Thus An Exemplary Statement Of Constructivism, Which States That: "Self-Realization Is The Ultimate Fact Of Facts. An Actuality Is Self-Realizing, And Whatever Is Self-Realizing Is An Actuality" (Whitehead, 1927–1928/1985, P. 222). The "Capture Of Intensity" And The "Clutch At

Vivid Immediacy" Are Thus The Defining Characteristics Of Life (Whitehead, 1927–1928/1985, P. 105). Finally, I Have Suggested That It Is Only On The Basis Of A Deep Extension Of The Concept Of Experience Throughout Nature That Whitehead Is Able To Resoundingly Affirm His Reformed Notion Of The Subjectivist Principle: "That Apart From The Experiences Of Subjects There Is Nothing, Nothing, Nothing, Bare Nothingness" (1927–1928/1985, P. 167). "Scientific Reasoning Is Completely Dominated By the Presupposition That Mental Functionings Are Not Properly Part of Nature" (Whitehead, 1938/1966, P. 156). (Ibid). Lewis Carroll Is Wonderful In Exploring Some Of The Paradoxes Of Logic. Following Some Of These Paradoxes Will Lead To The Important Role Of 'Sense' In Understanding. [NB Weird Titles Are Deleuze's Own]. First Series Of Paradoxes Of Pure Becoming: We Need To Explore The Nature Of An Event. Events Assume Becoming, Since They Refer To States In The Past And The Future In A Way Which 'Eludes The Present'. This Is Paradoxical But Still Makes Sense. Plato Tried To Distinguish Between Limited Fixed Things And Pure Becoming, But The Two Cannot Be Separated. Instead, A Dualism Is Hidden In Material Bodies. We Need To Introduce The Notion Of A Simulacrum Which Is Neither Copy Nor Model [Massumi Has A Useful Article On This—Roughly, The Issue Is That What We Take To Be Material Reality Is Actually A Simulacrum Of The Virtual, A Limited Condensation 'Beneath Things' (2)]. It Also Avoids The Problems Of Subsuming Reality Under The Idea. Sometimes, This Is Indicated By A Summer The Peculiarities Of Language, Which Can Seem To Flow Over Specific Referents. This Provides A Clue That There Is Some Dimension To Language Which Serves To Come To The Aid Of More Specific Attempts To Name And Describe. There Are Implications For Identity. Fully Grasping Becoming Means That Identities Are Infinite, Incorporating Future And Past, Active And Passive, And Even Cause And Effect. Language Attempts To Limit This Infinity, But Still Often Alludes To It [With Open-Ended Statements Or Generalisations]. As With The Alice Stories, This Also Disrupts The Conventional Notion Of The Personal Identity. Normally, This Is Maintained By Some Underlying Commonsense Or Knowledge, As When 'The Personal Self Requires God And The World In General' (3). Becoming Threatens This Stability With The Paradox Of Events, Which Can Penetrate Even Commonsense—It Is Not Just A Doubt About Reality, But A Clear Indication Of The 'Objective Structure Of The Event Itself, Insofar As It Moves In Two Directions At Once, And Insofar As It Fragments The Subject Following This Double Direction' (3). Second Series Of Paradoxes Of Surface Effects: Stoics Divided Things Into Bodies And States Of Affairs, 'Actions And Passions' (4). There Is Also Some Cosmic Unifying Quality, Always In The Present. Bodies Can Interact and Cause Effects in Each Other, But These Effects Are Incorporeal, 'Logical or Dialectical Attributes… Not Things or Facts but Events' (5). They Have The Kind Of Subsidiary Existence, Acting As Verbs, And They Are Infinitives—The Example Is A Cut Inflicted On The Body, Which Is Seen As An Incorporeal Surface Effect, Compared To The Actuality Of Bodies And Their Mixtures. This Argument Had Important Implications For Understanding The Causal Relation. Specific Bodily Causes Produce Other Bodies, Linked By Some Cosmic Unity Or Destiny. Similarly, Effects Can Be Seen As Having Bonds Between Them, But Effects Can Never Be Causes In Themselves. They Can Only Be '"Quasi-Causes' Following Laws Which Perhaps Express In Each Case The Relative Unity Or Mixture Of Bodies On Which They Depend For Their Real Causes' (6). These Combinations and Bonds to Provide For Some Emergent Qualities, Which Means That Destiny Can Be Avoided. An Alternative Is Offered By The Epicurean Classification Of Different Kinds Of Causes Which Are Relatively Independent [And So Can Interact], And This Is A Kantian Idea Too. There Is A Reference Back To The Capacities Of Language To Offer 'A Declension Of Causes... [And]... A Conjugation of Effects' (6). Stoic Philosophy Introduces The Notion Of A Something Behind Both Specific Material Beings And Incorporeal Events. The Idea Must Belong To 'This Impassive Extra-Being Which Is Sterile, Inefficacious, And On The Surface Of Things: The Ideational Or The Incorporeal Can No Longer Be Anything Other Than An "Effect"' (7). This In Turn Leads To A Change Of Metaphor From Surface/Depth To Just Surface, To A Series Of Effects Which Are Manifestations And Are Of Different Types. We Have A Notion of Possibilities, Of Ideality Itself, Rather Than the Platonic Idea, But With No 'Causal and Spiritual Efficacy' (7). The Simulacrum Now Appears On The Surface, Rather Than Being Hidden In The Depths. Events As Effects Combine Past And Present, Active And Passive, All Of Which Are Located Elsewhere As Causes. The Relation Between Events Can Only Be Quasi-Causes. Stoics Saw Dialectical Analysis Has Explorations Of These Combinations, Once They Had Been Expressed In

Propositions—Dialectics As Conjugation. Language Also Enables Us To Go Beyond Events Into The Possible Or Becoming. The Relation Between Propositions And Specifics Is Itself Still Paradoxical—'Chryssipus Taught "If You Say Something It Passes Through Your Lips, So If You Say "Chariot", A Chariot Passes Through Your Lips' (8). It Is Deliberate Nonsense In The Anglo American Sense, Or Humourous Play On The Surface, As Opposed To An Ironic Exploration Of Depths And Heights. Lewis Carroll Did Something Similar In Alice. [A Commentary On Alice Ensues, Stressing The Surface Rather Than The Underground World, And Picking Up The Disdain Lewis Carroll Felt For Boys Who Did Not Like To Operate At The Surface. Left Handers And Stutterers Can Sometimes Remind Us Of The Paradoxes Of The Surface, However, Which Can Defeat Commonsense Understandings]. Third Series Of The Proposition: Describing Events As Propositions Raises The Question Of How Best To Analyse Surface Events. There Are Three Possibilities: Denotation [Roughly, A Direct Connection Between Words And Images Which Represent States Of Affairs, As In Indexical Signs. Here, Propositions Are Either True Or False, And May Be True In All Cases]; Manifestation -- A Relation Between The Proposition And The Person Expressing It, Statements Of Desire And Belief. These Are Causal Relations: 'Desire Is The Internal Causality Of An Image With Respect To The Existence Of The Object Or The Corresponding State Of Affairs' (13). Belief Anticipates Production Of An Effect By A Cause. Manifestation Includes Denotation, Makes It Possible. '"I" Is the Basic Manifester' (13). Manifestation Is 'The Domain Of The Personal, Which Functions As The Principle Of All Possible Denotation' (13). The Issues Here Turn On Veracity Other Than Truth And Falsehood, The Avoidance Of Illusion. Signification, The Relation Of A Word To Universal Or General Concepts, And Connections To Implications Which Have To Follow The Rules Of Syntax. Again, Signifying Involves Conceptual Implications Referring To Other Propositions, As In Premises Or Conclusions. This Involves A Certain Indirect Process, Implication Or Assertion, Instead Of Truth Or Veracity, Which Remain As Possible In Certain Conditions. However, It Is Not Just Formal Logical Operations That Are Involved, But Notions Of Probability Or Even Moral Terms Such As Promise Or Commitment. Error Produces Not Falsehood But Absurdity [Looks Really Close To Habermas and the Three Validity Claims Here]. Signification May Not Be Primary, Since All Language Begins From The Standpoint Of The 'I', But There Is An Assumption That Propositions Must Be Understood By Others And Have A General Force. This Implies That Manifestation Has Primacy. But Signification Is Implied, And [In Social Relations] Would Be The Basis Of Manifestation. It Is The Difference Between Langue And Parole. Particular Utterances Only Make Sense Against The Background Of Constant Concepts. This Is Extended To Particular Desires And Beliefs, As Opposed To 'Simple Opinions' Which Would Not Signify (16). Actual Utterances Often Involve Truth Claims And General Signification [And Other Presuppositions, Which Are Technically Infinite]. This Is The Paradox Facing Pure Logic, Solved By A Form Of [Smuggling]: 'Implication Never Succeeds In Grounding Denotation Except By Giving Itself A Ready- Made Denotation, Once In The Premises And Again In The Conclusion' (16). So Actual Propositions Feature Circular Relations between Signification, Manifestation, and Denotation. There Might Even Be A Fourth Dimension—Sense, But Introducing This Will Depend On Making Relations Theoretically Consistent—It Is 'Not Simply A Question Of Fact' (17). To Approach The Issue, We Ask Whether Sense Might Be Located In One Of The Existing Three. Denotation Concerns Itself With Truth And Falsity, Which Is Too Narrow. The Mere Relation Between Words And Denoted Things Is To Paradoxical To Always Makes Sense, As In The Example Of Speaking The Term 'Chariot'. Instead, Denotation Presupposes Sense. Manifestation Does Involve Some Manifesting Subject Which Initiates, So May Be Sense Is Itself A Subjective Matter Of Beliefs And Desires Of Persons—But Subjects Only Possess This Ability To Speak Because Of A General System Of Signification In Language. It Looks Like Sense Must Be Identified With Signification—But Signification Is Linked In A Circular Relation With Denotation And Manifestation. Perhaps it's Necessary to Think Of Different Forms of Possibility of Propositions—Logical, Physical, Syntactic and So On. This Might Serve As Foundations For Sense, But This Would Be An External Foundation, Independent Of Speech [I Think The Problem Is The Connections Between Any Foundations And Actual Act Of Speech, Whether Anything Would Escape The Foundations]. The Concept Of Truth In Particular Implies Independence From Form. This Independence, Separate From Conceptual Possibilities In Signification, Is What Constitutes Sense. This Is The Fourth Dimension. It Is 'An Incorporeal, Complex, And Irreducible Entity, At The Surface Of Things' (19). There

Is Philosophers Have Discovered And Rediscovered This Quality. It Is The Idea Of A Something Again, Beyond The Propositions And The Terms And The Objects Which Are Denoted, Beyond The Subjective I And Things Which Are Expressed. Sense Is Irreducible To Propositions, and It Is and Must Be '"Neutral," Altogether Indifferent To Particular and General, Singular and Universal, Personal and Impersonal' (19). There Is Been Little Agreement About This Possible Fourth Dimension, Whether It Exists Simply In The Form Of Some Enquiry. It Is Not Even Immediately Useful Because It Is Neutral. It Can Only Be Inferred Indirectly, By Questioning Characteristics Of Propositions As Above—This Is 'Inspired In Its Entirety By Empiricism… [Avoiding Notions of Essence or Idea, and Knowing]… Have To Track Down, Invoked And Perhaps Produce A Phantom At The Limit Of A Length Or Unfolded Experience' (20). It Might Be What Husserl Called 'Expression', Lingering In Terms Such As The Noema, As Pure Appearance, Outside Denotation Or Manifestation, Linked In Complex Ways To Appearances. In The Same Way, Sense Does Not Exist Outside Propositions Exactly, But 'Inheres or Subsists' (21). It Is Not Just An Expression, But An Attribute, Not Just Of The Proposition, But 'Of The Thing Or State Of Affairs' (21), [The Potential, 'To Be Able To Be Green' Rather Than Just The Denotation 'Green' Is The Example Here]. It Is Said Of A Thing, So It Depends On Propositions Which Express It And Is Therefore Not Separate From The Proposition. It Is Something Else, Both the Expressible, And the State Of Affairs: 'It Turns One Side towards Things and One Side towards Propositions' (22). It Is What Joins Propositions And Things. [It Is A Becoming]. It Operates On The Surface, Rather As Mathematics Does, Or The Nonsense Of Carroll. It Is The Operation Of Sense That Produces [Meaningful] Paradox. Fourth Series Of Dualities: Important Dualities Exist Between Causes And Effects, And 'Corporeal Things And Incorporeal Events' (23). This Is Extended To A Duality Between Things And Propositions, Bodies And Language. This Is Expressed In Lewis Carroll As A Duality Between Eating And Speaking—The Former Is A Matter Of Bodies Actions And Passions, And The Latter Movements Of The Surface And 'Ideational Attributes Or Incorporeal Events' (23) [Lots Of Examples From Alice About Being Presented To Food And Having Food Presented To You]. The Normal Relationship Can Be Distorted By 'Verbal Hallucinations… Unrestricted Oral Behaviour… And Various Disorders of the Surface' As Bodily Matters Intrude—Stuttering, Left Handedness (24). Sense Is Always Expressed In Propositions, But It Lies In States of Affairs, It Happens To Things. In This Sense, Bodies And Language Are United In The Production Of Sense, Existing 'On The Two Sides Of The Frontier Represented By Sense', Which Constantly Articulates The Differences (24)—Things Include 'Ideational Logical Attributes Which Indicate Incorporeal Events', And Propositions Include Both Denotations And Expressions, Names And Adjectives, And Verbs [The Latter Indicating Becoming And Chains Of Events] (24) [Illustrated With Words By Humpty Dumpty]. This Duality In Propositions Represents Two Dimensions, The 'Denotation Of Things And The Expression Of Sense' (25) [Here, It Is Sense That Is Being Expressed Not Subjectivity, However]. This Means The Duality Is Inherent In Propositions As Well As Between Propositions And Things. [More From Lewis Carroll Page 26, Turning On The Universal Denotation Implied By The Term 'It', And Also The Ability Of The Term To Summarise The Sense Of An Earlier Proposition]. The Two Dimensions Can Emerge In an Esoteric Word, Or In A 'Non Identifiable Aliquid' (26). The Example Given Is The Word 'Snark' [Both A Limited Thing And A Representation Of Anything That Is Too Exotic To Exist?]. [The Section ends with an Extended Quotation from the Gardener's Song in Sylvie And Bruno—Pass] Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable to Constraints on Space Accomodation Model Is Provided in Some Paper in the series Notwithstanding the Generality and Commonalty of the Observation and Its Concatenatability with the Other Modules. The Scholars Of Tien Tai Called It The "Embodied Nature". (This Is The Buddha-Nature That Includes Both Good And Evil.) The Scholars of Xian Shou Say, "It Is Arising From Primal Nature", And the Scholars of Chan (Zen) Say, "It Is Nature That Causes the Rising of Things". All Dharma Is Dharma-Nature. It Is Not Different From Dharma-Nature. Dharma And Dharma-Nature Are Not Two Separate Identities, "Phenomena" And "Nature" Is Also Not Distinguishable Either. In Other Words, There Is No Difference Between Principle (Absolute) And Practice (Relative). Teachings in Chinese Buddhism (6) Sunyata (Emptiness) In the Mahayana Context (Wikipedia). The reason for becoming, according to Whitehead, is always the actual entity itself. He called this the ontological principle. The entity "enjoys" its relations and is "satisfied" by its own becomings. Whiteheads theory of process and relations can be viewed as an experiential alternative view of quantum physics which incorporates a theory of mind. However, Whitehead's master work, Process and Reality (1929/1978), is nearly impossible to fully understand, has its own idiosyncratic vocabulary, and is not entirely self-consistent. This relative opacity of Whitehead's work has impeded the generalization of his quantum process theory, or metaphysics, to other areas of discourse. In his independent formulation of the microgenesis of the mental state, Jason Brown discovered a process theory of mind that had many similarities to Whiteheadian process. He took the concepts of duration and discontinuities of process and applied them to the duration of the mental state as it recapitulates the contents of prior mental states. Through the introduction of novelty, and through the process of microgenesis during the progression of mental states, the Self gives rise to a percept of self, the ego, in the object world, at the termination of the microgenetic process. This termination is the conscious instant, or instantiation of the microgenetic process. It is all that we consciously see. We see the ego, not the Self, and thus mistake the ego for self, replacing self with selfhood. The process itself is obscured from our consciousness, but can be inferred from those neurological deficit syndromes, which expose lower "layers" in the becoming. This parallels the "layers" of the nested hierarchy of holographic surfaces in the brain itself. Brown is theory of microgenesis involves a progression in the genesis of the mental state in a developmental sequence that recapitulates the organism is evolutionary development (phylogeny), embryologic development (ontogeny), and history of personal and social experience and development, in a movement in an upward direction through structures of increasing phylogenetic and ontogenic recency (Brown, 1988, 1991, 1996, 1998, 2005). He developed a view that considered the evolution of mental states to be a continuum from depth to surface, with leaps or saltation between mental states at intervals that are temporally irreducible units of the duration of microgenetic process (Brown, 1996, 1998). The process of neoteny, through which earlier features of development and evolution are brought to the present, was described (Brown, 1996) as a change in the development of some aspect of the mental state, which is attenuated at some stage of elaboration. In neurological and psychiatric deficit syndromes, this attenuation corresponds with the locus of a lesion or functional deficiency. The signature of the attenuated stage is carried through the remaining process of microgenesis, leading to expression of the attenuated phase at the endpoint of the duration of microgenesis, coupled with full elaboration of other elements of microgenesis. The intellectual pedigree of the theory of microgenesis dates back to the principle of superposition of Sir Charles Lyell, according to which younger strata lie on top of older strata. Lyell, a geologist, was to have great influence on evolutionary theorists, including Darwin and Wallace. The principle of superposition was taken up by Herbert Spencer, a scholar of many fields, who was a contemporary of Charles Darwin, and who had developed an evolutionary theory that perhaps rivaled Darwin is in popularity during the late 1800ís and early 1900ís. An important element of Spencer is theory was his observation of the brain, which he fashioned to be layered, with the newer layers added on to older layer during the course of evolution. Looking at the deeper layers was, for Spencer, like peeling away the layers of an onion. Spencer is idea was taken up by the renowned British neurologist Hughlings Jackson (Kennard and Swash eds., 1989), who developed the notion of hierarchies of brain process and the concept of neurological deficit syndromes as disturbances in the hierarchical structure and function of the brain. The concepts of microgeny and microgenesis, derived from hierarchies of brain function, were later developed by Arieti (1962) and Werner (1956). Later, the concept of a hierarchy of adaptive ego mechanisms, including lower order defenses such as denial and reaction formation, and higher order defenses such as altruism, was developed by Vaillant (1971), with the more mature defense mechanisms bearing on higher order values. The process theory of the evolution of the brain is extraordinarily important to Brown is process theory of mind. We can place these theories in perspective with the process theory of Whitehead, into which the theory of Brown partially merged (Brown, 1996; 1998; 2005). The materialist perspective of evolution, was, according to Whitehead (1925/1953), inconsistent with the process by which organisms become: "...in truth, a thoroughgoing evolutionary philosophy is inconsistent with materialism. The aboriginal stuff, or material, from which a materialistic philosophy starts, is incapable of evolution. This material is in itself the ultimate substance. Evolution, in the materialistic theory, is reduced to the role of being another word for the description of the changes of the external relations between portions of matter. There is nothing to evolve, because one set of external relations is as good as any other set of external relations. There can merely be change, purposeless and unprogressive." Whitehead is (1929/1978) realm of eternal objects, apprehended in the unconscious, can be viewed as a basic element in the evolution of organisms and of mind. Whitehead (1929/1978), in his view of eternal objects, hearkens is back to Plato: "...eternal objects, as in Gods primordial nature, constitute the Platonic world of ideas." Whitehead is realm of eternal objects may include Carl Jung is (1934/1967) archetypes of the collective unconscious (Griffin, ed., 1989), connecting Whitehead is cosmology to the corpus of literature on depth psychology. Jung is archetypes were largely based on mythological, religious, and alchemical constructs. Mythology embodies the spiritual and social history of the species, as well as a variety of metaphysical metaphors (Campbell, 1969/1976; Neumann, 1954/1970). The physical nature of the brain state, including the notion of binding of the mental state into a coherent whole, is also critical to Brown is theory of microgenesis. Recent evidence indicates that the brain is a chaotic or dynamical system (Freeman, 1987; Combs, 2004; Abraham, 2004). The self-organization of dynamical systems, which include all living organisms as well as the brain, has been described in detail by Ilya Prigogine (1980), who won the Nobel Prize in chemistry in 1977 for his work on dynamical systems. Prigogine defines an "internal time" or duration of the states of dynamical systems. Physical time, he states, is secondary, and internal time is primary (Prigogine, 1986). The dynamical interval of internal time, or duration, is governed by the baker transformation (Prigogine, 1980), which can be envisioned as the time it takes the baker to knead or fold two different colors of dough successively, until it seems to be uniform in color. The brain, as a dynamical system, thus "deposits" time in the sense of Brown (1996). Here we have a parallel with the "layering" of process time according to the Holographic Principle. We can also detect, remotely, the undertones of Lyellís principle of superposition, albeit in a different form, and in a sense that Lyell could never have imagined. The work of Jason Brown in process neurology and psychology stands in sharp contrast to the prevailing scientific and philosophical nihilism in these fields regarding the self, free will, and the process of experience. In the sense of Brown is theory of microgenetic process of the brain, and in the sense of the duration of process discontinuities of Whitehead as it relates to the mind, it is important for the purposes of this paper to explore the scientific basis of the brain state. Mental process involves successive durations of such states, each with a "temporal thickness" (Brown, 1996). In recent years the "brain electrical microstate" has been described in detail as patterns of electrical field potential which endure for a period a period of time, typically around 100 milliseconds or a tenth of a second, and are punctuated by rapid transitions to the next state (Fingelkurts and Fingelkurts, 2001; Koenig and others, 2002). Brain electrical microstates are prime candidates for the brain states of microgenetic process and for the dynamical interval of internal time. The application of the theory of discontinuous information states, with the complete repetition of former states, as applied to the Holographic Principle of Mind, requires an information theory that includes time and the duration of mental states (e.g. Germine, 1993).The process of microgenesis, as it applies to brain evolution, can be seen in purely classical way, related to the recapitulation theory of vertebrate brain evolution (Agoutis, Montiel, and Lopez, 2002), which implies that "sensory projection sites and sites and processing circuits have been conserved [recapitulated] in reptiles and mammals" in the course of evolution. Again, there is an element of predictability in evolution which seems to belie the purposelessness of random natural selection. In keeping with the Holographic Principle, the development of the organism is a product of its evolutionary history, and is in continuous intercourse with that history. Microgenesis is readily related to the Holographic Principle of Mind, whereby the past remains actual, and, in the course of each mental state or mental process, there is a literal recapitulation of the organisms' entire past. The depth to surface principle entails a direction of mental process which is essential to microgenesis, and which is explained naturally by the nested hierarchy of surfaces in the brain according to the Holographic Principle. In the Holographic Principle of Mind we have a universal principle of microgenesis, whereby the entire relevant history of the organism is repeated during the course of each timeless and eternal moment. In this way, microgenesis can extend back to the very inception of the Universe. MICROGENESIS AND THE HOLOGRAPHIC PRINCIPLE the Holographic Principle Theory of Mind MARK GERMINE Institute for Psycho Science. Aristotle and others (including, especially, Leibniz) have argued that time does not exist independently of the events that occur in time. This view is typically called either "Reductionism with Respect to Time" or "Relationism with Respect to Time," since according to this view; all talk that appears to be about time can somehow be reduced to talk about temporal relations among things and events. The opposing view, normally referred to either as "Platonism with Respect to Time" or as "Substantivalism with Respect to Time" or as "Absolutism with Respect to Time," has been defended by Plato, Newton, and others. On this view, time is like an empty container into which things and events may be placed; but it is a container that exists independently of what (if anything) is placed in it. Time First published Mon Nov 25, 2002; substantive revision Fri Jan 24, 2014Markosian, Ned, "Time", The Stanford Encyclopedia of Philosophy (Spring 2014 Edition), Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/spr2014/entries/time/>. The question of whether there could be time without change has traditionally been thought to be closely tied to the question of whether time exists independently of the events that occur in time. For, the thinking goes, if there could be a period of time without change, then it follows that time could exist without any events to fill it; but if, on the other hand, there could not be a period of time without change, then it must be that time exists only if there are some events to fill it. Time First published Mon Nov 25, 2002; substantive revision Fri Jan 24, 2014Markosian, Ned, "Time", The Stanford Encyclopedia of Philosophy (Spring 2014 Edition), Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/spr2014/entries/time/>."Whoever thou mayest be, beloved stranger, whom I meet here for the first time, avail thyself of this happy hour and of the stillness around us, and above us, and let me tell thee something of the thought which has suddenly risen before me like a star which would fain shed down its rays upon thee and every one, as befits the nature of light. - Fellow man! Your whole life, like a sandglass, will always be reversed and will ever run out again; - a long minute of time will elapse until all those conditions out of which you were evolved return in the wheel of the cosmic process. And then you will find every pain and every pleasure, every friend and every enemy, every hope and every error, every blade of grass and every ray of sunshine once more, and the whole fabric of things which make up your life. This ring in which you are but a grain will glitter afresh forever. And in every one of these cycles of human life there will be one hour where, for the first time one man, and then many, will perceive the mighty thought of the eternal recurrence of all things:- and for mankind this is always the hour of Noon". Notes on the Eternal Recurrence - Vol. 16 of Oscar Levy Edition of Nietzsche's Complete Works (in English). Physical time is public time, the time that clocks are designed to measure. Biological time, by contrast, is indicated by an organism's circadian rhythm or body clock, which is normally regulated by the pattern of sunlight and darkness. Psychological time is different from both physical time and biological time. Psychological time is private time. It is also called phenomenological time, and it is perhaps best understood as awareness of physical time. Psychological time passes relatively swiftly for us while we are enjoying an activity, but it slows dramatically if we are waiting anxiously for the pot of water to boil on the stove. The slowness is probably due to focusing our attention on short intervals of physical time. Meanwhile, the clock by the stove is measuring physical time and is not affected by any person's awareness or by any organism's biological time. When a physicist defines speed to be the rate of change of position with respect to time, the term "time" refers to physical time, not psychological time or biological time. Physical time is more basic or fundamental than psychological time for helping us understand our shared experiences in the world, and so it is more useful for doing physical science, but psychological time is vitally important for understanding many mental experiences. Psychological time is faster for older people than for children, as you notice when your grandmother says, "Oh, it's my birthday again." That is, an older person's psychological time is faster relative to physical time. Psychological time is slower or faster depending upon where we are in the spectrum of conscious experience: awake normally, involved in a daydream, sleeping normally, drugged with anesthetics, or in a coma. Some philosophers claim that psychological time is completely transcended in the mental state called nirvana because psychological time slows to a complete stop. There is general agreement among philosophers that, when we are awake normally, we do not experience time as stopping and starting Time First published Mon Nov 25, 2002; substantive revision Fri Jan 24, 2014Markosian, Ned, "Time", The Stanford Encyclopedia of Philosophy (Spring 2014 Edition), Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/spr2014/entries/time/>. But From The Profound Contemplation And Wisdom Of The Buddha And Mahabodhisattvas, We Know There Is No Such Reality. Instead, Egolessness (Non-Self) Is The Only Path To Understand The Reality Of The Deluded Life. All Existences Are Subject To The Law Of Causes And Conditions. These Include The Smallest Particles, The Relationship Between The Particles, The Planets, And The

Relationship Between Them, Up To And Including The Whole Universe! From The Smallest Particles To The Biggest Matter, There Exists No Absolute Independent Identity. Egolessness (Non-Self) Implies The Void Characteristics Of All Existence. Egolessness (Non-Self) Signifies The Non-Existence Of Permanent Identity For Self And Existence (Dharma). Sunyata Stresses The Voidness Characteristic Of Self And Existence (Dharma). Sunyata And Egolessness Possess Similar Attributes. As We Have Discussed Before, We Can Observe The Profound Significance Of Sunyata From The Perspective Of Inter-Dependent Relationships. Considering Dharma-Nature and the Condition of Nirvana, All Existences Are Immaterial and Of A Void-Nature. Then We See Each Existence As Independent Of Each Other. But Then We Cannot Find Any Material That Does Exist Independent Of Everything Else. So Egolessness Also Implies Void-Nature! From The Observation Of All Existences, We Can Infer The Theory Of Nirvana And The Complete Cessation Of All Phenomena. From The Viewpoint Of Phenomena, All Existences Are So Different From Each Other, That They May Contradict Each Other. They Are So Chaotic. In Reality, Their Existence Is Illusionary And Arises From Conditional Causation. They Seem To Exist On One Hand, And Yet Do Not Exist On The Other. They Seem To Be United, But Yet They Are So Different To One Another. They Seem To Exist And Yet They Do Cease! Ultimately Everything Will Return To Harmony And Complete Calmness. This Is The Nature Of All Existence. It Is The Final Resting Place For All. If We Can Understand This Reality And Remove Our Illusions, We Can Find This State Of Harmony And Complete Calmness. Teachings in Chinese Buddhism (6) Sunyata (Emptiness) In the Mahayana Context (Wikipedia) for models please see one of the papers in the series. “The Difference Between Supermind And Big Mind (If We Take Big Mind To Mean The State Experience Of Nondual Suchness, Or Turiyatita) Is That Big Mind Can Be Experienced Or Recognized At Virtually Any Lower Level Or Rung. Magic to Integral. In Fact, One Can Be At, Say, The Pluralistic Stage, And Experience Several Core Characteristics Of The Entire Sequence Of State-Stages (Gross To Subtle To Causal To Witnessing To Nondual), Although, Of Course, The Entire Sequence, Including Nondual Suchness, Will Be Interpreted In Pluralistic Terms. This Is Unfortunate In Many Ways—Interpreting Dharma In Merely Pluralistic Terms (Or Mythic Terms, Or Rational, And So On)—Because It Is So Ultimately Reductionistic; But It Happens All The Time, Given The Relative Independence Of States And Structures At 1st And 2nd Tier. Supermind, On The Other Hand, As A Basic Structure-Rung (Conjoined With Nondual Suchness) Can Only Be Experienced Once All The Previous Junior Levels Have Emerged And Developed, And As In All Structure Development, Stages Cannot Be Skipped. Therefore, Unlike Big Mind, Supermind Can Only Be Experienced After All 1st-, 2nd-, and 3rd-Tier Junior Stages Have Been Passed Through. While, As Genpo Roshi Has Abundantly Demonstrated, Big Mind State Experience Is Available To Virtually Anybody At Almost Any Age (And Will Be Interpreted According To The View Of Their Current Stage), Supermind Is An Extremely Rare Recognition. Supermind, As The Highest Structure-Rung To Date, Has Access To All Previous Structures, All The Way Back To Archaic—And The Archaic Itself, Of Course, Has Transcended And Included, And Now Embraces, Every Major Structural Evolution Going All The Way Back To The Big Bang. (A Human Being Literally Enfolds And Embraces All The Major Transformative Unfoldings Of The Entire Kosmic History—Strings To Quarks To Subatomic Particles To Atoms To Molecules To Cells, All The Way Through The Tree Of Life Up To Its Latest Evolutionary Emergent, The Triune Brain, The Most Complex Structure In The Known Natural World.) Supermind, In Any Given Individual, Is Experienced As A Type Of “Omniscience”—The Supermind, Since It Transcends And Includes All Of The Previous Structure-Rungs, And Inherently Is Conjoined With The Highest Nondual Suchness State, Has A Full And Complete Knowledge Of All Of The Potentials In That Person. It Literally “Knows All,” At Least For The Individual.” ― Ken Wilber, The Fourth Turning: imagining the Evolution of an Integral Buddhism (fopr models please see one of the papers in the series). “The Movement Of Descent And Discovery Begins At The Moment You Consciously Become Dissatisfied With Life. Contrary To Most Professional Opinion, This Gnawing Dissatisfaction With Life Is Not A Sign Of "Mental Illness," or An Indication Of Poor Social Adjustment, or A Character Disorder. For Concealed Within This Basic Unhappiness With Life And Existence Is The Embryo Of A Growing Intelligence, A Special Intelligence Usually Buried Under The Immense Weight Of Social Shams. A Person Who Is Beginning To Sense The Suffering Of Life Is, At The Same Time, Beginning To Awaken To Deeper Realities, Truer Realities. For Suffering Smashes To Pieces The Complacency Of Our Normal Fictions About Reality, And Forces Us To Become Alive In A Special

Sense—To See Carefully, To Feel Deeply, To Touch Ourselves And Our Worlds In Ways We Have Heretofore Avoided. It Has Been Said, And Truly I Think, That Suffering Is The First Grace. In A Special Sense, Suffering Is Almost A Time Of Rejoicing, For It Marks The Birth Of Creative Insight. But Only In a Special Sense. Some People Cling To Their Suffering As A Mother To Its Child, Carrying It As A Burden They Dare Not Set Down. They Do Not Face Suffering With Awareness, But Rather Clutch At Their Suffering, Secretly Transfixed With The Spasms Of Martyrdom. Suffering Should Neither Be Denied Awareness, Avoided, Despised, Not Glorified, Clung To, And Dramatized. The Emergence Of Suffering Is Not So Much Good As It Is A Good Sign, An Indication That One Is Starting To Realize That Life Lived Outside Unity Consciousness Is Ultimately Painful, Distressing, And Sorrowful. The Life Of Boundaries Is A Life Of Battles—Of Fear, Anxiety, Pain, And Finally Death. It Is Only Through All Manner Of Numbing Compensations, Distractions, And Enchantments That We Agree Not To Question Our Illusory Boundaries, The Root Cause Of The Endless Wheel Of Agony. But Sooner Or Later, If We Are Not Rendered Totally Insensitive, Our Defensive Compensations Begin To Fail Their Soothing And Concealing Purpose. As A Consequence, We Begin To Suffer In One Way Or Another, Because Our Awareness Is Finally Directed Toward The Conflict-Ridden Nature Of Our False Boundaries And The Fragmented Life Supported By Them." ― Ken Wilber, No Boundary: eastern and Western Approaches to Personal Growth for models please see one of the papers in the series. "To The Extent That You Actually Realize That You Are Not, For Example, Your Anxieties, Then Your Anxieties No Longer Threaten You. Even If Anxiety Is Present, It No Longer Overwhelms You Because You Are No Longer Exclusively Tied To It. You Are No Longer Courting It, Fighting It, Resisting It, Or Running From It. In The Most Radical Fashion, Anxiety Is Thoroughly Accepted As It Is And Allowed To Move As It Will. You Have Nothing To Lose, Nothing To Gain, By Its Presence Or Absence, For You Are Simply Watching It Pass By. Thus, Any Emotion, Sensation, Thought, Memory, Or Experience That Disturbs You Is Simply One With Which You Have Exclusively Identified Yourself, And The Ultimate Resolution Of The Disturbance Is Simply To Dis-Identify With It. You Cleanly Let All Of Them Drop Away By Realizing That They Are Not You--Since You Can See Them, They Cannot Be The True Seer And Subject. Since They Are Not Your Real Self, There Is No Reason Whatsoever For You To Identify With Them, Hold On To Them, Or Allow Yourself To Be Bound By Them. Slowly, Gently, As You Pursue This Dis-Identification "Therapy," You May Find That You is Entire Individual Self (Persona, Ego, and Centaur), Which Heretofore You Have Fought to Defend and Protect, Begins to Go Transparent and Drop Away. Not That It Literally Falls Off And You Find Yourself Floating, Disembodied, Through Space. Rather, You Begin To Feel That What Happens To Your Personal Self—Your Wishes, Hopes, Desires, Hurts—Is Not A Matter Of Life-Or-Death Seriousness, Because There Is Within You A Deeper And More Basic Self Which Is Not Touched By These Peripheral Fluctuations, These Surface Waves Of Grand Commotion But Feeble Substance. Thus, Your Personal Mind-And-Body May Be In Pain, Or Humiliation, Or Fear, But As Long As You Abide As The Witness Of These Affairs, As If From On High, They No Longer Threaten You, And Thus You Are No Longer Moved To Manipulate Them, Wrestle With Them, Or Subdue Them. Because You Are Willing To Witness Them, To Look At Them Impartially, You Are Able To Transcend Them. As St. Thomas Put It, "Whatever Knows Certain Things Cannot Have Any Of Them In Its Own Nature." Thus, If The Eye Were Colored Red, It Wouldn't Be Able To Perceive Red Objects. It Can See Red Because It Is Clear, Or "Redless." Likewise, If We Can But Watch Or Witness Our Distresses, We Prove Ourselves Thereby To Be "Distress-Less," Free Of The Witnessed Turmoil. That Within Which Feels Pain Is Itself Pain-Less; That Which Feels Fear Is Fear-Less; That Which Perceives Tension Is Tensionless. To Witness These States Is To Transcend Them. They No Longer Seize You From Behind Because You Look At Them Up Front." ― Ken Wilber, No Boundary: eastern and Western Approaches to Personal Growth (for models please see one of the papers in the series). "The Difference Between Supermind And Big Mind (If We Take Big Mind To Mean The State Experience Of Nondual Suchness, Or Turiyatita) Is That Big Mind Can Be Experienced Or Recognized At Virtually Any Lower Level Or Rung. ………………………In Difference and Repetition (1968, English 1994), Deleuze Develops His Project in Multiple Directions. His Work, He Says, Stems From The Convergence Of Two Lines Of Research: The Concept Of Difference Without Negation, And The Concept Of Repetition, In Which Physical And Mechanical Repetitions Are Masks For A Hidden Differential That Is Disguised And Displaced. His Major Focus Is A

Thoroughgoing Critique Of Representational Thinking, Including Identity, Opposition, Analogy, And Resemblance (Deleuze 1994, 132). For Deleuze, "Appearances Of" Are Not Representations, But Sensory Intensities Free Of Subjective Or Objective Identities (Deleuze 1994, 144). Without These Identities, Appearances Are Simulacra of A Non-Apparent Differential He Calls the "Dark Precursor" Or "The In-Itself of Difference" (Deleuze 1994, 119). This Differential Is The Non-Sensible Being Of The Sensible, A Being Not Identical To The Sensible, Or To Itself, But Irreducibly Problematic Insofar As It Forces Us To Encounter The Sensible As "Given." Furthermore, Any Move Against Representational Thinking Impinges Upon The Identity Of The Subject. Where Kant Founds The Representational Unity Of Space And Time Upon The Formal Unity Of Consciousness (Kant 1964, 135-137), Difference Re-Distributes Intuitions Of Past, Present, And Future, Fracturing Consciousness Into Multiple States Not Predicable Of A Single Subject. Intensive Qualities Are Individuating By Themselves, Says Deleuze, And Individuality Is Not Characteristic Of A Self Or An Ego, But Of A Differential Forever Dividing Itself And Changing Its Configuration (Deleuze 1994, 246, 254, 257). In Nietzschean Fashion, The "I" Refers Not To The Unity Of Consciousness, But To A Multitude Of Simulacra Without An Identical Subject For Whom This Multitude Appears. Instead, Subjects Arise And Multiply As "Effects" Of The Intensive Qualities Saturating Space And Time. This Leads Deleuze to Postulate Multiple Faculties for Subjectivity, Which Are Correlates of the Sensible Insofar As It Gives Rise to Feeling, Thought, and Action. "Each Faculty, Including Thought, Has Only Involuntary Adventures," He Says, And "Involuntary Operation Remains Embedded In The Empirical" (Deleuze 1994, 145). Subjectively, The Paradox Of The Differential Breaks Up The Faculties' Common Function And Places Them Before Their Own Limits: Thought Before The Unthinkable, Memory Before The Immemorial, Sensibility Before The Imperceptible, Etc. (Deleuze 1994, 227). This Fracturing And Multiplying Of The Subject, He Notes, Leads To The Realization That "Schizophrenia Is Not Only A Human Fact But Also A Possibility For Thought" (Deleuze 1994, 148), Thus Expanding The Term Into A Philosophical Concept, Beyond Its Clinical Application. Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative for models kindly see one of the papers in the series, procrastinated due to restrictions on space. The Dissolution Of The Subject And Its Implications For Society Is The Theme Of Anti-Oedipus: Capitalism And Schizophrenia, Which Deleuze Published With Félix Guattari In 1972 (English 1983). The Book, In Large Part, Is Written Against An Established Intellectual Orthodoxy Of The Political Left In France During The 1950s And 1960s, An Orthodoxy Consisting Of Marx, Freud, And Structuralist Concepts Applied To Them By Louis Althusser And Jacques Lacan. Deleuze And Guattari Argue That This Mixture Is Still Limited By Representational Thinking, Including Concepts Of Production Based Upon Lack, And Concepts Of Alienation Based Upon Identity And Negation. Furthermore, The Oedipus Concept In Psychoanalysis, They Say, Institutes A Theater Of Desire In Which The Psyche Is Embedded In A Family Drama Closed Off From The Extra-Familial And Extra-Psychic Forces At Work In Society. They Characterize These Forces As "Desiring Machines" Whose Function Is To Connect, Disconnect, And Reconnect With One Another Without Meaning Or Intention. The Authors Portray Society As A Series Of "Territorializations" Or Inscriptions Upon The "Body Without Organs, "Or The Free-Flowing Matter Of Intensive Qualities Filling Space In Their Varying Degrees. The First Inscriptions Are Relations Of Kinship And Filiation Structuring Primitive Societies, Often Involving The Marking And Scarring Of Human Bodies. As An Interruption and Encoding of "Flows," The Primitive Inscriptions Constitute a Nexus of Desiring Machines, Both Technical and Social, Who's Elements Are Humans and Their Organs. The Full Body Of Society Is The Sacred Earth, Which Appropriates To Itself All Social Products As Their Natural Or Divine Precondition, And To Whom All Members Of Society Are Bound By Direct Filiation (Deleuze 1983b, 141-42). These First Inscriptions Are Then De-Territorialized And Re-Coded By The "Despotic Machine," Establishing New Relations Of Alliance And Filiation Through The Body Of The Ruler Or Emperor, Who Alone Stands In Direct Filiation To The Deity (Deleuze 1983b, 192) And Who Institutes The Mechanism Of The State Upon Pre-Existing Social Arrangements. Finally, Capitalism De-Territorializes The Inscriptions Of The Despotic Machine And Re-Codes All Relations Of Alliance And Filiation Into Flows Of Money (Deleuze 1983b, 224-27). The Organs Of Society And The State Are Appropriated Into The Functioning Of Capital, And Humans Become Secondary To The Filiation Of Money With Itself. Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative For Models Kindly See One Of The Papers In The Series, Procrastinated Due To Restrictions On Space. Deleuze And Guattari See In The Capitalist Money System "An Axiomatic Of Abstract Quantities That Keeps Moving Further And Further In The Direction Of The Deterritorialization Of The Socius" (Deleuze 1983a, 33), Which Is To Say That Capital Is Inherently Schizophrenic. However, Because Capital Also Re-Territorializes All Flows Into Money, Schizophrenia Remains Capitalism's External Limit. Nevertheless, It Is Precisely That Limit Against Which Thinking Can Subject Capitalism To Philosophical Critique. Psychoanalysis, They Say, Is Part Of The Reign Of Capital Because It Re-Territorializes The Subject As "Private" And "Individual," Instituting Psychic Identity Through Images Of The Oedipal Family. However, The Oedipal Triangle Is Merely A Representational Simulacrum Of Kinship And Filiation, Re-Coded Within A System Of Debt And Payment. In This System, They Insist, Flows Of Desire Have Become Mere Representations Of Desire, Cut Off From The Body Without Organs And The Extra-Familial Mechanisms Of Society. A Radical Critique Of Capital Cannot Therefore Be Accomplished By Psychoanalysis, But Requires A Schizoanalysis "To Overturn The Theater Of Representation Into The Order Of Desiring-Production" (Deleuze 1983b, 271). Here, The Authors See A Revolutionary Potential In Modern Art And Science, Where, In Bringing About The "New," They Circulate De-Coded And De-Territorialized Flows Within Society Without Automatically Re-Coding Them Into Money (Deleuze 1983a, 379). In This Revolutionary Aspect, Anti-Oedipus Reads As A Statement Of The Desire That Took To The Streets Of Paris In May Of 1968, And Which Continues, Even Now, To Make Itself Felt In Intellectual Life. Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative For Models Kindly See One Of The Papers In The Series, Procrastinated Due To Restrictions On Space. The Term "Deconstruction," Like "Postmodernism," Has Taken On Many Meanings In The Popular Imagination. However, In Philosophy, It Signifies Certain Strategies For Reading And Writing Texts. The Term Was Introduced Into Philosophical Literature In 1967, With The Publication Of Three Texts By Jacques Derrida: Of Grammatology (English 1974), Writing And Difference (English 1978), And Speech And Phenomena (English 1973). This So-Called "Publication Blitz" Immediately Established Derrida As A Major Figure In The New Movement In Philosophy And The Human Sciences Centered In Paris, And Brought The Idiom "Deconstruction" Into Its Vocabulary. Derrida And Deconstruction Are Routinely Associated With Postmodernism, Although Like Deleuze And Foucault, He Does Not Use The Term And Would Resist Affiliation With "-Isms" Of Any Sort. Of The Three Books From 1967, Of Grammatology Is The More Comprehensive In Laying Out The Background For Deconstruction As A Way Of Reading Modern Theories Of Language, Especially Structuralism, And Heidegger's Meditations On The Non-Presence Of Being. It Also Sets Out Derrida's Difference With Heidegger Over Nietzsche. Where Heidegger Places Nietzsche Within The Metaphysics Of Presence, Derrida Insists That "Reading, And Therefore Writing, The Text Were For Nietzsche 'Originary' Operations," (Derrida 1974, 19), And This Puts Him At The Closure Of Metaphysics (Not The End), A Closure That Liberates Writing From The Traditional Logos, Which Takes Writing To Be A Sign (A Visible Mark) For Another Sign (Speech), Whose "Signified" Is A Fully Present Meaning. This Closure Has Emerged, Says Derrida, With The Latest Developments In Linguistics, The Human Sciences, Mathematics, And Cybernetics, Where The Written Mark Or Signifier Is Purely Technical, That Is, A Matter Of (e) Function Rather Than Meaning. Precisely The Liberation Of Function Over Meaning Indicates That The Epoch Of (e) What Heidegger Calls The Metaphysics Of Presence Has Come To Closure, Although This Closure Does Not Mean Its Termination. Just As In The Essay "On The Question Of Being" (Heidegger 1998, 291-322) Heidegger Sees Fit To Cross Out The Word "Being," Leaving It Visible, Nevertheless, Under The Mark, Derrida Takes The Closure Of Metaphysics To Be Its "Erasure," Where It Does Not Entirely Disappear, But Remains Inscribed As (=) One Side Of A Difference, And Where The Mark Of Deletion Is (=) Itself A Trace Of The Difference That Joins And Separates (e&eb, e(e&eb))This Mark And What It Crosses Out. Derrida Calls This Joining And Separating Of Signs Différance (Derrida 1974, 23), A Device That Can Only Be Read And Not Heard When (e) Différance And Différence Are Pronounced In French. The "A" Is A Written Mark That Differentiates Independently Of The Voice, The Privileged Medium Of Metaphysics. In This Sense, Différance As The Spacing Of Difference, As Archi-Writing, Would Be (eb) The Gram Of Grammatology. However, As

Derrida Remarks: “There Cannot Be (=) A Science Of Difference Itself In Its Operation, As It Is Impossible To (e) Have A Science Of The Origin Of Presence Itself, That Is To Say Of A Certain Non-Origin” (Derrida 1974, 63). Instead, There Is (=) Only The Marking Of (e) The Trace Of Difference, That Is, Deconstruction. Because (e) At Its Functional Level All Language Is A System Of Differences, Says Derrida, All Language, Even When Spoken, Is Writing, And This Truth Is Suppressed When Meaning Is Taken As An Origin, Present And Complete Unto Itself. Texts That Take Meaning Or Being As Their Theme Are Therefore Particularly Susceptible To Deconstruction, As Are All Other Texts Insofar As They Are Conjoined With These. For Derrida, Written Marks Or Signifiers Do Not Arrange Themselves Within Natural Limits, But Form Chains Of Signification That Radiate In All Directions. As Derrida Famously Remarks, “There Is No Outside-Text” (Derrida 1974, 158), That Is, The Text Includes The Difference Between Any “Inside” Or “Outside.” A Text, Then, Is Not A Book, And Does Not, Strictly Speaking, Have An Author. On The Contrary, The Name Of The Author Is A Signifier Linked With Others, And There Is No Master Signifier (Such As The Phallus In Lacan) Present Or Even Absent In A Text. This Goes For The Term “Différance” As Well, Which Can Only Serve As A Supplement For The Productive Spacing Between Signs. Therefore, Derrida Insists That “Différance Is Literally Neither A Word Nor A Concept” (Derrida 1982, 3). Instead, It Can Only Be Marked As A Wandering Play Of Differences That Is Both A Spacing Of Signifiers In Relation To One Another And A Deferral Of Meaning Or Presence When They Are Read. How, Then, Can Différance Be Characterized? Derrida Refuses To Answer Questions As To “Who” Or “What” Differs, Because To Do So Would Suggest There Is A Proper Name For Difference Instead Of Endless Supplements, Of Which “Différance” Is But One. Structurally, This Supplemental Displacement Functions Just As, For Heidegger, All Names For Being Reduce Being To The Presence Of Beings, Thus Ignoring The “Ontological Difference” Between Them. However, Derrida Takes The Ontological Difference As One Difference Among Others, As A Product Of What The Idiom “Différance” Supplements. As He Remarks: “Différance, In A Certain And Very Strange Way, (Is) ‘Older’ Than The Ontological Difference Or Than The Truth Of Being” (Derrida 1982, 22). Deconstruction, Then, Traces The Repetitions Of The Supplement. It Is Not So Much A Theory About Texts As A Practice Of Reading And Transforming Texts, Where Tracing The Movements Of Différance Produces Other Texts Interwoven With The First. While There Is Certain Arbitrariness In The Play Of Differences That Result, It Is Not The Arbitrariness Of A Reader Getting The Text To Mean Whatever He Or She Wants. It Is A Question Of Function Rather Than Meaning, If Meaning Is Understood As A Terminal Presence, (eb)And The Signifying Connections Traced In Deconstruction Are First Offered By The Text Itself. A Deconstructive Reading, Then, Does Not Assert Or Impose Meaning, But Marks Out Places Where The Function Of The Text Works Against Its Apparent Meaning, Or Against The History Of Its Interpretation. Hyperreality is closely related to the concept of the simulacrum: a copy or image without reference to an original. In postmodernism, hyperreality is the result of the technological mediation of experience, where what passes for reality is a network of images and signs without an external referent, such that what is represented is representation itself. In Symbolic Exchange and Death (1976) (English 1993), Jean Baudrillard uses Lacan's concepts of the symbolic, the imaginary, and the real to develop this concept while attacking orthodoxies of the political Left, beginning with the assumed reality of power, production, desire, society, and political legitimacy. Baudrillard argues that all of these realities have become simulations, that is, signs without any referent, because the real and the imaginary have been absorbed into the symbolic Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative For Models Kindly See One Of The Papers In The Series, Procrastinated Due To Restrictions On Space. Magic to Integral. In Fact, One Can Be At, Say, The Pluralistic Stage, And Experience Several Core Characteristics Of The Entire Sequence Of State-Stages (Gross To Subtle To Causal To Witnessing To Nondual), Although, Of Course, The Entire Sequence, Including Nondual Suchness, Will Be Interpreted In Pluralistic Terms. This Is Unfortunate In Many Ways—Interpreting Dharma In Merely Pluralistic Terms (Or Mythic Terms, Or Rational, And So On)—Because It Is So Ultimately Reductionistic; But It Happens All The Time, Given The Relative Independence Of States And Structures At 1st And 2nd Tier. Supermind, On The Other Hand, As A Basic Structure-Rung (Conjoined With Nondual Suchness) Can Only Be Experienced Once All The Previous Junior Levels Have Emerged And Developed, And As In All Structure Development, Stages Cannot Be Skipped.

Therefore, Unlike Big Mind, Supermind Can Only Be Experienced After All 1st-, 2nd-, and 3rd-Tier Junior Stages Have Been Passed Through. While, As Genpo Roshi Has Abundantly Demonstrated, Big Mind State Experience Is Available To Virtually Anybody At Almost Any Age (And Will Be Interpreted According To The View Of Their Current Stage), Supermind Is An Extremely Rare Recognition. Supermind, As The Highest Structure-Rung To Date, Has Access To All Previous Structures, All The Way Back To Archaic—And The Archaic Itself, Of Course, Has Transcended And Included, And Now Embraces, Every Major Structural Evolution Going All The Way Back To The Big Bang. (A Human Being Literally Enfolds And Embraces All The Major Transformative Unfoldings Of The Entire Kosmic History—Strings To Quarks To Subatomic Particles To Atoms To Molecules To Cells, All The Way Through The Tree Of Life Up To Its Latest Evolutionary Emergent, The Triune Brain, The Most Complex Structure In The Known Natural World.) Supermind, In Any Given Individual, Is Experienced As A Type Of "Omniscience"—The Supermind, Since It Transcends And Includes All Of The Previous Structure-Rungs, And Inherently Is Conjoined With The Highest Nondual Suchness State, Has A Full And Complete Knowledge Of All Of The Potentials In That Person. It Literally "Knows All," At Least For The Individual." — Ken Wilber, The Fourth Turning: imagining the Evolution of an Integral Buddhism (fopr models please see one of the papers in the series). As Lyotard Argues, Aesthetic Judgment Is The Appropriate Model For The Problem Of Justice In Postmodern Experience Because We Are Confronted With A Plurality Of Games And Rules Without A Concept Under Which To Unify Them. Judgment Must Therefore Be Reflective Rather Than Determining. Furthermore, Judgment Must Be Aesthetic Insofar As It Does Not Produce Denotative Knowledge About A Determinable State Of Affairs, But Refers To The Way Our Faculties Interact With Each Other As We Move From One Mode Of Phrasing To Another, I.E. The Denotative, the Prescriptive, the Performative, the Political, the Cognitive, the Artistic, Etc. In Kantian Terms, This Interaction Registers As An Aesthetic Feeling. Where Kant Emphasizes The Feeling Of The Beautiful As A Harmonious Interaction Between Imagination And Understanding, Lyotard Stresses The Mode In Which Faculties (Imagination And Reason,) Are In Disharmony, I.E. The Feeling of the Sublime. For Kant, The Sublime Occurs When Our Faculties Of Sensible Presentation Are Overwhelmed By Impressions Of Absolute Power And Magnitude, And Reason Is Thrown Back Upon Its Own Power To Conceive Ideas (Such As The Moral Law) Which Surpass The Sensible World. For Lyotard, However, The Postmodern Sublime Occurs When We Are Affected By A Multitude Of Unpresentables Without Reference To Reason As Their Unifying Origin. Justice, Then, Would Not Be A Definable Rule, But Ability To Move And Judge Among Rules In Their Heterogeneity And Multiplicity. In This Respect, It Would Be More Akin To The Production Of Art Than A Moral Judgment In Kant's Sense. Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative. The Scholars Of Tien Tai Called It The "Embodied Nature". (This Is The Buddha-Nature That Includes Both Good And Evil.) The Scholars of Xian Shou Say, "It Is Arising From Primal Nature", And the Scholars of Chan (Zen) Say, "It Is Nature That Causes the Rising of Things". All Dharma Is Dharma-Nature. It Is Not Different From Dharma-Nature. Dharma And Dharma-Nature Are Not Two Separate Identities, "Phenomena" And "Nature" Is Also Not Distinguishable Either. In Other Words, There Is No Difference Between Principle (Absolute) And Practice (Relative). Teachings in Chinese Buddhism (6) Sunyata (Emptiness) In the Mahayana Context (Wikipedia). In Other Words, All Dharma Arises From Causes and Conditions, and All Dharma Is Empty In Nature. The Law of Dependent Origination (Existence) and the Nature of Emptiness Is Neither the Same nor Different. They Exist Mutually. The Truth of "Sunyata" And "Existence", And "Nature" And "Phenomena" Are Not (e&eb) In Conflict With Each Other. Unlike The Scholars Of The Dharmalaksana Sect Who Explain The Dharma Only From (e) The Aspect Of Dependent Origination, Or The Scholars Of Dharma-Nature That Explain The Existence Of Dharma Only From The Aspect Of Dharma-Nature, The Scholars Of Madhyamika Explain The Truth Of The Dharma From Both Aspects. Hence This Is Called The Middle Path Which Does Not Incline To Either Side. Teachings in Chinese Buddhism (6) Sunyata (Emptiness) In the Mahayana Context (Wikipedia). For Stoics, Causes Involved Reference To The Depths, But Effects At The Surface Could Also Have Relations Among Themselves. This Permitted The Distinction To Be Drawn Between Destiny And Necessity—The Stoics Wanted To Affirm Destiny And Deny Necessity. In The First Place, Effects Express Causes, But Expressions Of Relations [Rather Than Necessity]

Connects Those Effects. Those Relations May Be Described As Compatibility Or Incompatibility, Conjunction Or Disjunction. These Are Not Causal Relations Themselves, But Represent 'An Aggregate Of Noncausal Correspondences Which Form A System Of Echoes, Of Presumptions And Resonances, A System Of Signs—In Short, An Expressive Quasi Causality And Not At All A Necessitating Causality' (170). This Need Not Involve Contradiction, Which Is Applying To Events Rules That Really Only Applied To Logic And Argument. There Can Be Incompatability Without Contradiction, A Noncausal Correspondence. Leibniz Described Incompossible Worlds [Delanda Is Very Clear On This Too]. Only Impossible Events Contradict Possible Ones. Events Can Be Compossible [Roughly, They Have Predictable and Predicative Future and Past Events]. For Deleuze, It Is A Matter Of 'The Convergence Of Series Which Singularities Of Events Form As They Stretch Themselves Out Over Lines Of Ordinary Points. Incompossibility Must Be Defined By the Divergence of Such Series' (171). Such A Notion Is Essential To Any Theory of Sense. We Should Not See Divergence As A Matter Of Exclusion, As Leibniz Did [Since God Chose Actual Events]. Divergent And Disjunction Can Both Be Positive, While Preserving Differences. In Fact, Differences Are Crucial, Preserving The Distance Between Objects While Affirming That They Are Related. This 'Permits The Measuring Of Contraries Through Their Finite Difference Instead Of Equating Difference With A Measureless Contrariety' (173). It Is Contradiction Which Is The Special Case. Difference Here Is A Topological Term Relating To Distance On Surfaces Rather Than Depths. It Is Not Just A Matter Of Suggesting 'Some Unknown Identity Of Contraries (As In Commonplace In Spiritualist And Colorist Philosophy)' (173) [Take That St Pierre!]. An Example Is Nietzsche Arguing That Health And Sickness Can Both Inform Each Other; Act As Points Of View, Remembering That 'Things, Beings, Are Themselves Points Of View' (173). Divergence Does Not Mean Exclusion, And Disjunction Does Not Mean Separation. Connective Syntheses '(If…, Then)' Construct A Single Series; Conjunctive Series '(And)' Produces Convergent Series, But Disjunctive Series '(Or)' Produces A Divergence Series. Normally, Disjunction Helps Us To Criticise Synthesis, But Disjunction Can Still Be A Synthesis Itself, Despite Its Use In Logical Analysis [I Think What Is Going On Here Is Arguing That There Is A Difference Between 'Either/Or' In A Logical Sense, And 'One Or Two' In The Real Sense—The Latter Can Mean That Both Are Compossible. This Is The 'Communication Of Events' Rather Than The Logical Business Of Analysing Predicates (174)]. The Synthetic Disjunction Expresses The Paradox, With Divergence At The Centre. The Discussion of Paradoxes and Esoteric Words Above Are Examples: They Contract 'The Multitude of Divergent Series in the Successive Appearance of A Single One' (175). There Is A Difference Again Between the Subversion of the Present and Simple Identity by Depths, And Operations at the Surface. By Considering The Depths, We Encounter Infinite Identities [As Events Become Examples Of Deeper Categories, Wholes?]. At The Surface Events Communicate With Each Other Directly Through Maintaining Distance And By Affirming Disjunctions. Disjunction Threatens The Identity Of The Self, And Helps Us To See The Self As 'So Many Impersonal And Pre-Individual Singularities' [Connected Through Disjunctive Synthesis. Hence the Importance of Heterogeneity] (175). The Normal Concept Of The Self Implies Some Connected Series, 'But When Disjunction Accedes To The Principle Which Gives To It A Synthetic And Affirmative Value, The Self, The World, And God Share In A Common Death' (176). [There Is Also A Point That Divergent Series Explain And Also Exceed Normal Conjunctive And Connective Series]. In The Usual Conception, 'The Self Is the Principle of Manifestation, In Relation To the Proposition, the World Is the Principle of Denotation, And God the Principle of Signification' (176). But The Theory Of Sense Here Says That It Emanates From Nonsense, From Paradox, And From The 'Eternally Decentred Ex-Centric Centre' (176). This Position 'Does Not Tolerate the Subsistence of God as an Original Individuality, Nor The Self As The Person, Nor The World As An Element Of The Self And As God's Product. The Divergence Of The Affirmed Series Forms A "Chaosmos" And No Longer A World; The Aleatory Point Which Traverses Them Forms A Counter self, And No Longer A Self' (176). There Is No Centre But Only 'Pure Events Which The Instant, Displaced Over The Line [Of Aion], Goes On Dividing Into Already Past And Yet To Come. Nothing Other Than The Event Subsists… This Communicates With Itself through Its Own Distance and Resonates Across All of Its Disjuncts' (176). Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On

Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules Sixteenth Series Of The Static Ontological Genesis Twenty-fourth series of the communication of events. The Buddha Always Used The Terms Void, No Rising And Falling, Calmness And Extinction To Explain The Profound Meaning Of Sunyata And Cessation. For Example, Sunyata And The State Of Nirvana Where There Is No Rising Nor Falling, Are Interpreted By Most People As A State Of Non-Existence And Gloom. They Fail To Realise That Quite The Opposite, Sunyata Is Of Substantial And Positive Significance. The Sutras Often Use The Word "Great Void" To Explain The Significance Of Sunyata. In General, We Understand The "Great Void" As Something That Contains (e) Absolutely Nothing. However, From A Buddhist Perspective, The Nature Of The "Great Void" Implies Something Which Does Not Obstruct Other Things, In Which All Matters Perform Their Own Functions. Materials Are (=) Form, Which By Their Nature, Imply (eb) Obstruction. The Special Characteristic Of The "Great Void" Is (=) Non-Obstruction. The "Great Void" Therefore, Does Not (e) Serve As An Obstacle To (e) Them. Since The "Great Void" Exhibits No Obstructive Tendencies, It Serves As The Foundation For Matter To Function. In Other Words, If There Was Neither “Great Void” Nor Characteristic Of Non-Obstruction, It Would Be Impossible For The Material World To Exist And Function. The "Great Void" Is Not Separated From The Material World. The Latter Depends On The Former. We Can State That the Profound Significance of Sunyata and the Nature of Sunyata in Buddhism highlight The "Great Void’s" Non-Obstructive Nature. Sunyata Does Not Imply The "Great Void". Instead, It Is The Foundation Of All Phenomena (Form And Mind). It Is The True Nature Of All Phenomena, And It Is The Basic Principle Of All Existence. In Other Words, If The Universe’s Existence Was Not Empty Nor Impermanent, Then All Resulting Phenomena Could Not Have Arisen Due To (e) The Co-Existence Of Various Causes And There Would Be (=) No Rising Nor Falling. The Nature Of Sunyata Is Of Positive Significance. Calmness And Extinction Are The Opposite Of Rising And Falling. They Are Another Way To Express (eb) That There Is No Rising And Falling. Rising And Falling Are (=) The Common Characteristics Of Worldly Existence. All Phenomena Are Always In (eb)The Cycle Of Rising And Falling. However, Most People Concentrate On Living (Rising). They Think That The Universe And Life Are (=)The Reality Of A Continuous Existence. Buddhism On The Other Hand, Promotes (eb) The Value Of A Continuous Cessation (Falling). This Cessation Does Not (e) Imply That It Ceases To Exist Altogether. Instead, It Is Just A State In The Continuous Process Of Phenomena. In This Material World, Or What We May Call This "State Of Existence", Everything Eventually Ceases To (e) Exist. Cessation Is (=) Definitely The Home Of All Existences. Since Cessation Is The Calm State Of Existence And The Eventual Refuge Of All Phenomena, It Is Also The Foundation For All Activities And Functions. Teachings in Chinese Buddhism (6) Sunyata (Emptiness) In the Mahayana Context (Wikipedia). You Are In Your Own Film A Subjective Experience Where You Are Both Actor And Director Writing Your Script As You Go Along. You Are (=) Both The Audience And The Actor A Near State Of Pure Consciousness. You Are An Individual General Ledger With A Place In Collective General Ledger And Cosmic General Ledger With Celestial Brahman Anti Brahman Simulating (e&eb)The Events Which Appear To You On (eb) The Screen Of Consciousness. Sensations Are Disruptions Within Actual Identifications; They Are Signs Of The Expression Of Ideas And Intensities In Actual Structures. There Is No Denying the Difficulty of Deleuze’s Account of Reality – Necessary for an Understanding of the Role Played by Kantian Arguments. It May Therefore Be Helpful To Think In Terms Of An Example. You Have Waited Years To See A Loved One Again, Tarrying With Dimming Memories And Shifts In Longings And Needs. A Meeting Has Been Arranged. The Opening Gestures, Words And Images Bring Together Fixed Memories And Preconceptions (Actual Identifications) With Feelings That Destroy those (Actual Sensations Of Disappointment, Excitement, Bemusement, And Renewed Passion). The Power Of These Sensations Cannot Come Solely From The Disrupted Identities; Rather, They Are Expressions Of Deeper Charges (Virtual Intensities). But, Beyond Local Identifications And Their More And More Distant Actual Effects, Imagined And Even Undreamed Worlds Of Ideas Are Changed Through The Meeting. According To Deleuze, These Are Not Possible Worlds, But Virtual Ones That Ground Actual Identifications. The Actual Meeting Is Accompanied By A Virtual One, Where Ideas Take Shape And Acquire Significance Through Shifts In Relations Between Intensities. These Shifts Light Up Actual Situations In New Ways And Determine Different Ideas To Come Into Play. The Meeting Is A Failure. Intensities Push Feelings of Disappointment to the

Fore, Destroying One World of Ideas and Perhaps Determining a Colder One with Greater Clarity. The Transversal Thought of Gilles Deleuze: Encounters and Influences James Williams. For models please see one of the papers in the series. Models are procrastinated due to spatial restrictions. You Can Stir The Conscious State And Consequentially Connect All The Three States. As Lyotard Argues, Aesthetic Judgment Is The Appropriate Model For The Problem Of Justice In Postmodern Experience Because We Are Confronted With A Plurality Of Games And Rules Without A Concept Under Which To Unify Them. Judgment Must Therefore Be Reflective Rather Than Determining. Furthermore, Judgment Must Be Aesthetic Insofar As It Does Not Produce Denotative Knowledge About A Determinable State Of Affairs, But Refers To The Way Our Faculties Interact With Each Other As We Move From One Mode Of Phrasing To Another, I.E. The Denotative, the Prescriptive, the Performative, the Political, the Cognitive, the Artistic, Etc. In Kantian Terms, This Interaction Registers As An Aesthetic Feeling. Where Kant Emphasizes The Feeling Of The Beautiful As A Harmonious Interaction Between Imagination And Understanding, Lyotard Stresses The Mode In Which Faculties (Imagination And Reason,) Are In Disharmony, I.E. The Feeling of the Sublime. For Kant, The Sublime Occurs When Our Faculties Of Sensible Presentation Are Overwhelmed By Impressions Of Absolute Power And Magnitude, And Reason Is Thrown Back Upon Its Own Power To Conceive Ideas (Such As The Moral Law) Which Surpass The Sensible World. For Lyotard, However, The Postmodern Sublime Occurs When We Are Affected By A Multitude Of Unpresentables Without Reference To Reason As Their Unifying Origin. Justice, Then, Would Not Be A Definable Rule, But Ability To Move And Judge Among Rules In Their Heterogeneity And Multiplicity. In This Respect, It Would Be More Akin To The Production Of Art Than A Moral Judgment In Kant's Sense. Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative. In Dissolving All Social Phenomena In The Acid Bath Of Power And Domination, Foucault Prevents Critical Theory From Drawing Crucial Distinctions, Such As Those "Between Just And Unjust Social Arrangements, Legitimate And Illegitimate Uses Of Political Power, Strategic And Cooperative Interpersonal Relations, Coercive And Consensual Measures" (McCarthy 1991: 54). One Cannot Say, For Example, That One Regime Of Power Is Any Better Or Worse Than Another, Only That They Are Different -- "Another Power, Another Knowledge" (Foucault 1979: 226). Since Ruling Powers Attempt To Erase Such Distinctions, Or To Present Injustice As Justice, Falsehood As Truth, And Domination As Freedom, Foucault's Position Unwittingly Supports The Mystifications Of Orwellian Doublespeak, Now More Rife Than Ever (See Kellner 2001), And Blocks The Discriminations Necessary For Social Critique. If There Are No Standards Or Right, Then, With Thrasymacus And Hobbes, We Can Conclude Might Is As Right As Anything. There Can Be No Ideology Critique Where There Is No Distinction Between True And False, And any Social Or Moral Critique Without A Distinction Between Right And Wrong. The Evaluative Character Of Foucault's Own Work Is Not Any Less Normative For His Refusal To Explicitly Confront It. The Problem Becomes Glaring In His Later Work Where He Employs Normative Terms Such As Liberty And Autonomy, But Fails To State What We Should Be Free For. Foucault's Anti-Normative Stance Therefore Forces Him into Self-Defeating Value Neutrality. Richard Rorty, The Attack on Theory, And Renunciation of Radical Politics (for models see one of the papers in the series). Our Environment Can Either Open Up or Constrict Possibilities for Spiritual and Intellectual Growth. In The Politics Of Experience Laing Offers A Fine Passage From Erving Goffman’s Studies Encounters: There Seems To Be No Agent More Effective Than Another Person In Bringing A World For Oneself Alive, Or, By A Glance, A Gesture, Or A Remark, Shriveling Up The Reality In Which One Is Lodged. "The Anxiety Of Meaninglessness Is Anxiety About The Loss Of An Ultimate Concern, Of A Meaning Which Gives Meaning To All Meanings. This Anxiety Is Aroused By The Loss Of A Spiritual Center, Of An Answer, However Symbolic And Indirect, To The Question Of The Meaning Of Existence." Philosophy And Depression By Tim Ruggiero -- Paul Tillich, The Courage To Be (1952) As Quoted In Depression And The Threat Of Nonbeing Tim Ruggiero, September 4, 2001 (Philosophical Society.Com).The Dissolution Of The Subject And Its Implications For Society Is The Theme Of Anti-Oedipus: Capitalism And Schizophrenia, Which Deleuze Published With Félix Guattari In 1972 (English 1983). The Book, In Large Part, Is Written Against An Established Intellectual Orthodoxy Of The Political Left In France During The 1950s And 1960s, An Orthodoxy Consisting Of Marx, Freud, And Structuralist Concepts Applied To Them By Louis Althusser

And Jacques Lacan. Deleuze And Guattari Argue That This Mixture Is Still Limited By Representational Thinking, Including Concepts Of Production Based Upon Lack, And Concepts Of Alienation Based Upon Identity And Negation. Furthermore, The Oedipus Concept In Psychoanalysis, They Say, Institutes A Theater Of Desire In Which The Psyche Is Embedded In A Family Drama Closed Off From The Extra-Familial And Extra-Psychic Forces At Work In Society. They Characterize These Forces As “Desiring Machines” Whose Function Is To Connect, Disconnect, And Reconnect With One Another Without Meaning Or Intention. The Authors Portray Society As A Series Of “Territorializations” Or Inscriptions Upon The “Body Without Organs, “Or The Free-Flowing Matter Of Intensive Qualities Filling Space In Their Varying Degrees. The First Inscriptions Are Relations Of Kinship And Filiation Structuring Primitive Societies, Often Involving The Marking And Scarring Of Human Bodies. As An Interruption and Encoding of “Flows,” The Primitive Inscriptions Constitute a Nexus of Desiring Machines, Both Technical and Social, Who’s Elements Are Humans and Their Organs. The Full Body Of Society Is The Sacred Earth, Which Appropriates To Itself All Social Products As Their Natural Or Divine Precondition, And To Whom All Members Of Society Are Bound By Direct Filiation (Deleuze 1983b, 141-42). These First Inscriptions Are Then De-Territorialized And Re-Coded By The “Despotic Machine,” Establishing New Relations Of Alliance And Filiation Through The Body Of The Ruler Or Emperor, Who Alone Stands In Direct Filiation To The Deity (Deleuze 1983b, 192) And Who Institutes The Mechanism Of The State Upon Pre-Existing Social Arrangements. Finally, Capitalism De-Territorializes The Inscriptions Of The Despotic Machine And Re-Codes All Relations Of Alliance And Filiation Into Flows Of Money (Deleuze 1983b, 224-27). The Organs Of Society And The State Are Appropriated Into The Functioning Of Capital, And Humans Become Secondary To The Filiation Of Money With Itself. Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative For Models Kindly See One Of The Papers In The Series, Procrastinated Due To Restrictions On Space. "The Vanity Of Existence Is Revealed In The Whole Form Existence Assumes: In The Infiniteness Of Time And Space Contrasted With The Finiteness Of The Individual In Both; In The Fleeting Present As The Sole Form In Which Actuality Exists; In The Contingency And Relativity Of All Things; In Continual Becoming Without Being; In Continual Desire Without Satisfaction; In The Continual Frustration Of Striving Of Which Life Consists." (For Models See One of the Papers in the Series, Which Are Procrastinated Due to Spatial Constraints) -- Arthur Schopenhauer, "On the Vanity of Existence" as quoted in Philosophy and Depression by Tim Ruggiero. "There Is Little Conjunction Of Truth And Social 'Reality'. Around Us Are Pseudo-Events, To Which We Adjust With A False Consciousness Adapted To See These Events As True And Real, And Even As Beautiful. In The Society Of Men The Truth Resides Now Less In What Things Are Than In What They Are Not. Our Social Realities Are So Ugly If Seen In The Light Of Exiled Truth, And Beauty Is Almost No Longer Possible If It Is Not A Lie." (For Models See One of the Papers in the Series, Which Are Procrastinated Due to Spatial Constraints) -- R.D. Laing, the Politics of Experience. [We’re going to Use the Idea of a Game to Further Illustrate How the Virtual Is Imminent in the Actual. Why This Example? To Have A Go At The Metaphor Of Games In Philosophy? To Instate Lewis Carroll As Some Great Philosopher?] The Actual Games Have A Series Of Rules About Playing And Outcomes That Limit The Influence Of Chance. It’s Possible to Invert These Rules to arrive at an Ideal Game, With No Rules, And with the Full Operation of Chance [Which Describes the Virtual, I Suppose]. Carroll Describe Some. We Also Learn About Time And How It Operates. In Each Throw Of The Dice, Singularities Are Distributed As A ‘Nomadic And Non Sedentary Distribution, Wherein Each System Of Singularities Communicate And Resonates With The Others, Being At Once Implicated By The Others And Implicating Them In The Most Important Cast’ (60). This Game Can Only Be Played In Thought [Since Any Empirical Reality Limits Chance. Chance Is Fixed By The Mechanisms Of Say The Roulette Wheel]. Infinite Time Can Be Compared With Finite [Or Metric] Time. They Are Linked Together, Although It Is Useful To Consider Both. In Finite Time, The Present Exists And Features Mixtures Of Matter Which Are Temporally Realized And Can Take On A [Empirical] Depth. Any Other Kind of Time, Only the Past and Future Exist, and Colonise Moments in the Presence. It Offers An Unlimited Kind Of Time, Since The Gap Between Past And Future Is Endlessly Subdivided And Never Closed. It Is Neutral And Incorporeal. Here, the Present Is A ‘Pure Mathematical Instant’ (62). It Is The Time Of Events Which Are Always Things Which Have

Just Happened And Things Which Are About To Happen 'Never Something Which Is Happening' (63). As With The Operations Of Chance In A Game, Specific Events Or Throws Occupy A Time Which Is Smaller Than That Which Can Be Thought [That Is The Unfolding Of Singularities Which Happen Instantly?], And Also The Maximum Notion Of Time [I Can Only Grasped This By Thinking Of Specific Chances Being Understood By Their Location In Whole Sequences Of The Infinite Throws Of The Dice]. [There Is Some Stuff About The Eternal Return Here Too Which I Don't Understand—63 – 64]. 'The Aion Is The Straight Line Traced By The Aleatory [Unpredictable, Accidental] Point' [Search Me] Which Means That Events The Can Communicate With All The Others, As In Events Of The Aion Itself. This Sort Of Unity Is Not The Same Is An Empirical Corporeal Unity. The Aion Underpins or Circulates Within the Series of Events. This Also Helps Explain The Connection Between The Sense Of Propositions And The Sense Of States Of Affairs. [Weird. Making The Strongest Possible Case For Chance, I Assume. Denying Essence or Subjective Intent. Makes Empirical {Including Social} Science As Limited To The Finite And Metric, But Requiring Thought Experiments To Move To The 'Pure' Level? So Says Delanda Anyway, I Think]. Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Please See One Of The papers In The Series Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable and Ascribable To Constraints on Space Accomodation Model Is Provided In Some Paper, Notwithstanding the Generality and Commonalty of the Observation and Its Concatenatability with the Other Modules. [Particularly Dense And Baffling Stuff, Attempting To Show How The Subjective World Is A Derivative Of The Objective Play Of Singularities. Makes More Sense With Concrete And Familiar Examples As In Delanda's Stuff On Biological Membranes And Their Importance In Embryology, Instead Of The Abstract 'Surfaces' Of This Account]] Individuals Are Capable Of Infinite Description, Limited Only By Their Bodies To Express. Persons [Human Beings Based the More Abstract Notion of an Individual?] Can Only Produce Propositions To Describe The World To A Limited Extent. Both, However, Are 'Ontological Propositions' [That Is They Create A Kind Of Reality?]. Multiple Classes And Systems Of Categories Are Not Produced By Propositions. Instead We Have To Look At Something That Now Produces Human Propositions Themselves, As 'Material Instances' (118). [So Human Ontological Activity Only Realises Sense Making In The Form Of Denotations, Manifestations, And Signification As Above?]. Denotations And The Others Are Interconnected As We Saw Above. There Is Also No Simple Connection Between, Say, 'The Individual And Denotation, The Person And Manifestation, Multiple Classes Or Variable Properties And Signification' (119) [For Similar Reasons—For Example, Signification Depends On The Good Sense Already Established By Individuation]. The Whole Complex Structure Is Produced By Both Ontological And Logical Genesis. Sense Operates On The Whole Structure. [We Can See This Both In The Fragility Of Sense And Its Tendency To Be Threatened By Nonsense, And Because The Alternative Is Unpalatable—Language And Sense-Making Would Be Based On Nothing But A 'Undifferentiated Abyss' (120)]. So Sense, 'In Its Organization of Aleatory and Singular Points, Problems and Questions, Series and Displacement' (120) Generates both Logical Propositions and Also 'the Objective Correlates' Of Propositions… The Denoted, the Manifested, and the Signified' (120). The Notion Of An Error Suggests This Although In A Confused Way. Normally We Think Of Error As A Matter Of Truth Or Falsity, When Propositions Are Formed And Tested. However, When We Consider Problems Instead Of Propositions That Offer Solutions, The Category Of Sense Emerges Strongly. [We Have Seen Above the Problem Is an Objective Matter of Structured Possibilities]. We Can See How Both Knowledge And The Known Are Produced By This Structure. [Problematics Are Further Discussed As Involving Particular Distributions Of Singularities In Space And In Time. As Problems Condense Out, So Do Solutions—'The Synthesis Of The Problem With Its Conditions Engenders Propositions, Their Dimensions, And Their Correlates' (121)]. Sense Is Produced Or Expressed When Solutions, Expressed As Propositions, Correspond To Problems [Act As 'Instances Of A General Solution' (121)] It Is Common To Express Sense In An Interrogative Form [Although The Interrogative Also Includes A More Limited Operation As In The Closed Question]. Specific Questions And Solutions Are Already Determined By The Problematic, However—'The Problem In Itself Is The

Reality Of A Genetic Element, The Complex Theme Which Does Not Allow It To Be Reduced To Any Propositional Thesis' (122). It Is A Mistake To Define A Problem In Terms Of Possible Solutions [Which Arise From Human Consciousness]. This Would Mean Us 'Confuse Sense with Signification, and… Conceive Of the Condition Only In the Image of the Conditioned' (122). [This Autonomous Constitution Of Problems Shows The Inadequacy Of Subjective Conceptions. Seeing Problems As Derived From Propositions Expressing Solutions Would Also Infringe The Neutrality Of Sense]. Problems Are Neutral Insofar As [Modes Of] Propositions Are Concerned. For Example 'A Circle Qua Circle Is Neither A Particular Circle, Nor A Concept Represented In An Equation… It Is Rather A Differential System To Which An Emission Of Singularities Corresponds' (123). Problems In This Sense Exist In Propositions But Also Allude To None Being, As Above. As A Result, Problems Are Neutral, That Is 'Independent of both the Negative and the Affirmative' (123). The Neutrality of Sense Means It Is Never Just the Echo ['the Double'] Of Propositions. Working With Propositions Can Only Lead To A Partial Understanding Of Sense. We Have To Develop Another Conception, Not Based On Propositions Or On Images Of Conventional Logical Thinking. Philosophy Must 'Purge The Transcendental Field Of All Resemblance' In Order To Avoid Trap Of Consciousness As The Origin Of The Transcendental (123). However, The Earlier Discussions Defined The Neutrality Of Sense As An Effect Produced By Corporeal Causes. Here, We Are Implying That It Arises From Its Genetic Power [To Produce Problematics] And This Relates To A Quasi Cause. Sense Is Produced By Bodies In A Way Which Presupposes This More General Kind Of Sense. The More General Kind Operates In A Different Way, Not Through Concepts Or Describing Mixtures. This Time It Is a Matter of Depth [Of Bodies] and the Effects of a Surface. The Pulsations Of Bodies Produce Surfaces In Particular Ways, Sometimes As A Minimum Energy Conserving Form [Delanda's Soap Bubble], Sometimes As A More Complex Structure Of Multiplied Differentiated Surfaces [Stretched, Emulsified, Absorbing Etc Are The Examples Given, P. 124]. Surfaces Are Produced By the 'Actions and Passions of Mixed Bodies' (124). Surfaces Have No Thickness Of Their Own, Which Permits Contact Between The Internal And The External. The Quasi Causes Play On These Surfaces, As A Kind Of 'Fictitious Surface Tension… A Force Exerting Itself On The Plane Of The Surface' (125). Singularities Are Condensed Extended And Reshuffled. These Surfaces Have An Existence In Actual Physics, And Also In Metaphysics—The Surface Becomes The Transcendental Field, The Border Between Bodies And Propositions. As Such, The Surface Becomes The 'Locus Of Sense And Expression' (125). Propositions And Bodies Are Actually Articulated On Surfaces, 'So That Sense Is Presented Both As That Which Happens To Bodies And That To Which Insists [Sic] In Propositions' (125). It Is In This Process Of 'Doubling Up' That Neutrality Arises [I Think The Argument Here Is That Neutrality Is Not Some Disembodied Quality But A Function Of Surfaces Which Enable 'The Continuity Of Reverse And Right Sides' (125). It Is The Indifference Of The Objective, Immune To Appeals From Human Subjectivity?]. The Surface Enables Sense To Be Distributed, As Both The Expressed In Propositions, And The Event In Bodies [Depends On This Very General Definition Of 'Expression' Again - More General Than The Use Above Where It Means Human Expression As In Manifestation Etc]. If The Surface Is Destroyed, Bodies' Fall Back Into The Depth, The 'Primary Order [Some Sort Of Natural Being Which Cannot Be Named Or Expressed?] Which Grumbles Beneath the Secondary Organisation of Sense' (125). But On The Surface, Sense Is Unfolded And Is Also Affected By Quasi Causes. This Sense In Turn Individuates and Determines Bodies, and Signification, and All the Propositions 'The Entire Tertiary Arrangement or the Object of the Static Genesis' (126). Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules Sixteenth Series Of The Static Ontological Genesis. Chronos And Aion Are Compared In Terms Of The Importance Of The Present As Opposed To The Past And The Future. For Chronos, The Present Represents The Main Interest, Although There Is 'The Relativity Of Presents Themselves In Relation To Each Other. God Experiences As Present That Which for Me Is Future or Past, Since I Live Inside More Limited Presents' (162). The Present Is Corporeal, A Matter of Mixtures [Imperfect for Humans and Perfect in the Divine Present for Stoics as Above]. The Present Limits The Action Of Bodies [Compare This With

Bergsonian Stuff About The Present As A Cone—Here We Are Talking About Contraction And Dilation To Connect The Empirical With A Cosmic Present]. The Partial Mixtures Of Bodies In The Present Threaten To Subvert The Sufficiency Of The Notion. Stoics Had To Distinguish Between Good Or Bad Mixtures, For Example, Which Lead To Their Notion Of Cosmic Perfection, And To Aion. This Implies That Bodies Are Actually Nothing But Simulacra, And The Present Less Important Than The Future Or The Past. However, Chronos Represents the Only Kind Of Empirical Understanding [?] (164). For Aion, The Present Is A Mere Instant, Always Divided Into Past And Future. This Is A Different Way Of Subverting The Present As In Depth Metaphors [Some Of Which Appear To Linger In The Argument About Partial Mixtures Of Bodies In The Present?]. [Somehow], Aion Operates At The Surface, Since The Present Is Evaded In Favour Of The Instant Rather Than The Fathomless Depths. Aion Operates With Incorporeal Events, And Their Effects, Which Are Limitless And Infinite. Thus Aion Is 'The Eternal Truth Of Time: Pure Empty Form Of Time, Which Is Freed Itself Of Its Present Corporeal Content' (165) [I Think Delanda Is Much Clearer On The Differences Between Metric And Intensive Time]. Aion Is An Essential Element In The Development Of Language, Allowing Language To Escape Corporeal Determinations, Alluding To An Existence Outside Of The Present, Allowing Signification And Manifestation. [Once Having Escaped, Language Can Persist In Itself]. The Instant Demonstrates The Aleatory Point, Nonsense, And Quasi-Cause. It Is A Pure Abstraction And It 'Extracts Singularities From The Present, And From Individuals And Persons Which Occupy This Present' (166) [Because It Alludes To Future And Past, And Thereby Constitutes The Pure Event?]. Without The Notion Of Aion, We Would Only Be Left With Bodies And States Of Affairs, Not Language And Propositions. [The Argument Here Seems To Be That Language Necessarily Has A Future Element?]. The Surface Divides The Two Series Of States Of Affairs And Propositions, And Sense Can Now Relate To Propositions And Events [In The Form Of The Commentary On Events Mentioned Wayback At The Beginning?]. [There Is Some Sort Of Topological Connection Between Points, Lines And Surfaces, Presumably In Terms Of The Way In Which One Can Be 'Cut' From The One Above]. Actualizations Occur When Bodies, States Of Affairs And Mixtures Intersect At The Surface. This Is A Matter Of 'Imprisoning First Their Singularities Within The Limits Of Worlds, Individuals, And Persons' (167). However, There Is Always Something In Excess Of Actualizations, Which Alludes To The Quasi- Cause [Which Apparently Can Be Identified By Sages]. This Involves Analysing the 'Pure Perverse "Moment"', the Pure Operation—It Is Graspable At and As A Moment of Counter Actualization. Twenty-Third Series Of The Aionalexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules Sixteenth Series Of The Static Ontological Genesis. Wild And Wacky Stuff Here Relating To Artaud's Work. I Would Normally Chop It Out Altogether, Except It Provides Some Context For The Emergence Of The Phrase 'Body Without Organs' That Crops Up So Prominently In Anti Oedipus Sense Is Fragile And Is Threatened By Nonsense. Sometimes Such Nonsense Can Destroy Everything, And We See This If We Switch From The Playful Portmanteaux Of Carroll To The Schizophrenic Writings Of Artaud. These Are Real Examples Of Nonsense, Instead Of The Artificial Ones Discussed By Philosophers. Artaud Apparently Disliked Carroll, and Rendered Jabberwocky in A Much More Challenging Schizophrenic Language. Carroll Is Too Superficial, Whereas Schizophrenia Reveals The Real Problems With Language. Another Work Is Discussed, By Wolfson, To Focus On The Duality Between Things And Words. This Takes The Form Of Someone [Schizophrenic?] Experiencing A Problem In Translating From One Language To The Other, Which Somehow Becomes Transposed Into An Anxiety About Eating. A Schizophrenic Interlude Ensues Involving Associations Between Consonants As The Basis For Translation, And The Paradoxes That Emerge (85). The Same Basic 'Oral Duality (To Eat/To Speak)' Is Also Found In Carroll's Work, And In Artaud 's. However, In Caroll, Some Sense Is Retained Since This Duality Is Explored 'At The Surface' (86) [This Also Indicates, Apparently That The Operation Of Sense Of The Surface Shows Only A Quasi-Causal Relation Between Its Elements, Since There Are Incorporeal Elements Driving It]. For Artaud, The Classic Schizophrenic Symptoms Included The Absence Of Surface, Especially With Bodies. Apparently Freud Also Noticed This Tendency For

Schizophrenics To See Their Body As 'Punctured By An Infinite Number Of Little Holes' (87). The Body Therefore Incorporates Everything Into Its Depths, Everything Becomes Corporeal And Physical. The Surface No Longer Limits The Extension Of The Body. 'Hence The Schizophrenic Manner Of Living The Contradiction: Either In The Deep Fissure Which Traverses The Body, Or In The Fragmented Parts Which Encase One Another And Spin About' (87). The World Loses Its Meaning And Sense [Because It Can No Longer Split Sensation Into A Signifying And Signified Separated By A Surface?] Words Become Physical And Affect Bodies, Or They Burst Into Components [Which Relates Back To The Wolfson Example]. Schizophrenics Experience 'A Pure Language–Affect' (88) [Sic --Affect Not Effect]. Schizophrenics Manage This By Overcoming The Effects Of Language, As In The Strange Translation Activity In The Wolfson Example. In Artaud's Case The Solution Was To Create Special Words Expressing 'Values Which Are Exclusively Tonic And Not Written' (88). 'To These Values A Glorious Body Corresponds, Being A New Dimension Of The Schizophrenic Body, An Organism About Parts Which Operates Entirely By Insufflations, Respiration, Evaporation, And Fluid Transmission (The Superior Body Or Body Without Organs Of Antonin Artaud)' (88). This Solution Can Never Be Complete Because There Can Never Be A Total Separation Between Sufferings ['Passion'] And [Remedial] Action, And Passion Can Be Reintroduced, And The Body Corrupted-- A Schizophrenic Body Is Therefore A Constant Mixture Of Two Actions Or Principles. Artaud Tries To Invent A New Language Which Cannot Be Decomposed And Thus Cannot Be Colonised, A Language Of 'Consonantal Guttural And Aspirated Overloads' (89). The Words Are Joined By Some Invented Principle, In This Case A 'Palatalized' One (89) Which Blurs The Consonants Together And Prevents Them Being Written Down. The Result Is 'So Many Active Howls In One Continuous Breath' (89) [Sounds Very Much Like Tara's Dadaist Tone Poems --Artaud's Example On P.83]]. These Words Are Often The Equivalent To Portmanteaux [Some Examples Are Given On Page 90]. Using These Words Can 'Enact A Chain Of Associations… In A Region Of Infra Sense, According To A Fluid And Burning Principle Which Absorbs And Reabsorbs Effectively The Sense As Soon As It Is Produced' (90). So Two Sorts Of Words Related To Two Sorts Of Bodies, One Fragmented And One Without Organs. There Are Also Two Theatres Or Two Types Of Nonsense Implied Here: One Where Ordinary Words Are Decomposed Into Nonsense, And One Where Tonic Elements Alone Form Nonsensical Words. They Are Produced By Things Happening Beneath The Surface, Unlike Carroll's Playful Superficiality. The Two Signifying and Signified Series Disappear, and Non Sense Engulfs Signifiers and Signified. There Is No Surface Division To Separate The Expressivity Of Words And The Attributes Of Actual Bodies [Which Regulates Ordinary Language]. In Schizophrenic Language There Is No Grammar Or Syntax Either, Although Both Are Preserved In Carroll. Nevertheless, It Is Artaud Who Has 'Discovered A Vital Body And The Prodigious Language Of This Body… He Explored The Infra Sense Which Is Still Unknown Today' (93). However, Caroll Has Explored Those Important Surfaces, On Which 'The Entire Logic Of Sense Is Located' (93). We Can Still Find Schizoid Fragments In Ordinary Speech, But These Are Normally Reorganized. Similarly, Carroll Can Be Retranslated As A Schizophrenic Piece (92). But It Is Wrong To Generalise Here, 'Believing To Have Discovered Analogous Forms Which Create False Differences' (92). Psychoanalysis Should Operate With A Surface/Depth Structure Rather Than With Analogies—'It Is Geographical Before It Is Historical' (93). [While We Are Here, Note That 'It Is Hardly Acceptable… To Run Together a Child's Nursery Rhymes, Poetic Experimentations, And Experiences of Madness… [And] Justify the Grotesque Trinity of Child, Poet, and Madmen' (82-83). This Must Be A Problem For Those Who Think That Deleuze Is Arguing That Children Are Philosophers?] Thirteenth Series Of The Schizophrenic And The Little Girl Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable and Ascribable To Constraints on Space Accomodation Model Is Provided In Some Paper, Notwithstanding the Generality and Commonalty of the Observation and Its Concatenatability with the Other Modules. Singularities Constitute The Transcendental Field. The First Stage Of Actualization Involves The Derivation Of Individuals. Singularities Spread Out 'In a Determined Direction over a Line of Ordinary Points', Up To the Vicinity of another Singularity (109). When Series Converge, A World Is Constituted [And Other Worlds Arise From Diverging Series]. The Infinite System Of Singularities Are Selected And Rendered Finite By Individuals [Does He Mean Human

Individuals Throughout? I Think So] Who Combine Them, 'Spread Them Out Over Their Ordinary Lines' (109) And Even Form Them Again On Various Membranes. 'An Individual Is Therefore Always In A World As A Circle Of Convergence, And A World May Be Formed And Thought Only In The Vicinity Of The Individuals Which Occupy Or Fill It' (110). [Deleuze Is Suggesting That This Role For Individuals Is The Only Way For Worlds To Persist, Since Entropy Prevents The Endless Renewal Of Singularities At The Virtual Level—'The Power Of Renewal Is Conceded Only To Individuals In The World, And Only For A Time—The Time Of Their Living Present' (110). This Is Static Genesis, The First Level Of Actualization. Singularities Are Actualized In The World And In Individuals. Actualization Means Being Extended, Selected, Incarnated In A Body, And Renewed Locally. These Qualities Require Individuals. Actualization Also Means Being Expressed, But It Would Be Wrong To Assume That Only The Expressed World Exists. There Are, For Example Incompossible Worlds, Produced By Diverging Series [As Real Events, And Not Just Matters Of Contradictory Consciousness]. This Implies That There Is A Continuum Of Singularities Outside Of [Conscious] Individuals, Worlds In Which Other Possibilities Arise. [So Grasping These Other Possibilities Again Distinguishes Sense From Mere Logic, Based On The Truth And Falsity Of Propositions Expressed By Individuals]. Because Individuals Express Worlds, However, The World Looks As If It Is Merely Subjective, And Objective Events Appear To Be 'The Analytic Predicate Of A Subject' (112). [These Analytic Predicates Appear To Be Properties Of People Or Objects]. [Much Of This Argument Is Referring To Leibniz]. However, The Problem Is To Explain Logical Hierarchies Of Properties And General Categories. Subjective Analytic Predicates Have Immediacy, But Do Not Have Any Kind of Order; They Get Elaborated But Only As Mixtures. They Are Descriptive Of Actual Structures And Diversities. They Are 'Intuitions... Immediate Representations' (113). The Second Level Of Actualization Involves The Transcendental Again, Originally Conceived As The Development Of Transcendency In The Individual [See The Critique Of Husserl Above]. The Transcendental Ego Is Constituted Just As Other Individuals Are, As A Circle Of Convergences, So The Problem Is To Escape This And Develop Knowledge Of The Whole Continuum, Of Incompossible Worlds And Divergent Series, A New Sense Of World [Deleuze Uses The German Terms Welt For This New World And Umwelt For The Subjective World. I Am Grateful To Wikipedia For Explaining That: In The Semiotic Theories Of Jakob Von Uexküll And Thomas A. Sebeok, Umwelt (Plural: Umwelten; The German Word Umwelt Means "Environment" Or "Surrounding World") Is The "Biological Foundations That Lie At The Very Epicenter Of The Study Of Both Communication And Signification In The Human [And Non-Human] Animal."[Citation Needed] The Term Is Usually Translated As "Self-Centered World". [1] Uexküll Theorised That Organisms Can Have Different Umwelten, Even Though They Share The Same Environment']. Proper Transcendence Involves Transcending Individuated Worlds. Singularities Come With Their Own 'Perfectly Objective Determination Which Is The Open Space Of Its Nomadic Distribution' (113), And This Is How Deleuze Wants To Define A Problematic [Above]. Leibniz Apparently Half Grasped This Argument, Suggesting That Conic Sections, For Example, All Referred Back To The Same Event, Subdivided By 'Ambiguous Signs' (114). Similarly, Incompossible Worlds Also Have 'Something Objectively In Common', And 'Several Worlds Appear As Instances Of Solutions For One And The Same Problem... Variants of the Same Story... There Is Thus A"Vague Adam", That Is A Vagabond, A Nomad… Common to Several Worlds' (114). In Other Words, All The Objective And Subjective Worlds Can Be Explained By A Series Of Singularities. It Is Not Just The Analytic Predicates Of Individuals That Actualize Worlds. 'On The Contrary, [There] Are Predicates Which Define Persons Synthetically And Open Different Worlds And Individualities To Them As So Many Variables Or Possibilities' (115). It Is Incompossible Worlds Which Synthesise 'Primary Possibilities Or Categories' (115). These Possibilities or Categories 'Necessarily Signify Classes and Properties', And These Are Distinct From Individual Categories at the First Level. They Still Seen Grounded In Persons, But That Is 'Because Persons Themselves Are Primarily Classes Having One Single Member, And Their Predicates Are Properties Having One Constant' (115). There Is Thus A System Involving Persons, Classes With One Single Member, Extensive Classes And Variable Properties '-- That Is The General Concepts Which Derive From Them' (115). If There Is A Universal Ego, It Is Something That Corresponds To Common Elements In All Worlds. So, Firstly, Sense Gets Actualized In A Field Of Singularities, Then The Umwelt Develops Around Individuals Which Express Or Describe This World, Then, Secondly, A Whole

Objective World Develops From Common Elements, A Welt. Persons Can Then Define This Common Element And Develop Classes And Properties Derived From It. At The First Level We Find Good Sense, 'An Already Fixed And Sedentary Organization Of Differences'. At The Second Level, Commonsense Serves The Function Of Identification. Neither Term Explains How These Activities Are Derived [In Fact, Deleuze Wants To Suggest That The Second Level 'Is The Work Of Non Sense Which Is Always Copresent To Sense (Aleatory Point Or Ambiguous Sign)... Productive Nonsense Which Animates The Ideal Game And The Impersonal Transcendental Field' (116). There Is No Conventional Transcendental Movement, Especially One Driven By A Version Of The Ego. The Person Is A 'Produced Form, Derived From This Impersonal Transcendental Field… Always an Individual in General, Born… From The Singularity Which Extends Itself Over A Line of Ordinary Points and Starts from the Preindividual Transcendental Field' (116). Persons And Their Varieties Of Sense Are All Produced 'On The Basis Of Sense And Nonsense Which Do Not Resemble Them' (117). This Explains The Paradoxes And Limits Of Good Sense And Common Sense. [So The Existence Of Nonsense --Paradox And Impossible Sentences Etc -- In The Ordinary Subjective World Shows The Existence Of Non Sense --Something That Produces Ordinary Sense In The First Place, Something Objective? Individuals Can Only Describe But As Soon As They Generalise And Order Concepts They Necessarily Assume Some Non-Subjective World? The Man oeuvre seems Rather like the Illicit Transcendental Ego Move by Husserl, Generalising from an Ordinary Ego: Here, Explaining Ordinary Experience Is Used to Explain Some Deeper Virtual World as an Extension?] Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules Sixteenth Series Of The Static Ontological Genesis. The Issue Is Of The Validity Or Truth Of Propositions And How This Might Be Grounded. It Is As Difficult To Root Propositions In The Idea As It Is Actual Events. Significations Cannot Be Just Seen As Exhausted By Their Denoted Examples. A List Of Denoted Examples Would Be Endless And Groundless Anyway. Classic Philosophers Often Refuse To Answer Questions Denoted Examples Any Way, And Replied With A Blow From The Staff, Or A Mute Demonstration. After All, 'There Is No Resemblance (Nor Should There Be One) Between What One Points Out And What One Has Been Asked' (135) [Typical Philosophical Elitism]. The Issue Is Often Covered By Humour, Especially Irony or the Absurd. We Must Refuse Ascent and Descent and Occupy the Surface 'Where Pure Sense Is Produced' (136). At The Surface, 'One Finds Pure Singularities, An Emission Of Singularities Considered From This Perspective Of The Aleatory Element, Independent Of The Individuals And Persons Which Embody Or Actualise Them' (136). Getting To The Surface Involves Humour And Adventure, Seen In The Routines Of Zen Masters, Who Can Allude To The Void Which Is Present In Events [Events Are 'Not The Object As Denoted, But The Object As Expressed Or Expressible, Never Present, But Always Already In The Past And Yet To Come' (136), And The Abolition Of The Object Alludes To The Void]. Negating Objects Indicates The Expressible. [Examples From Zen Follow, Page 137. What They Seem To Be Suggesting Is That Sense Combines Actual Objects With The Notion Of The Void, Non Sense—An Actual Brushstroke And Also The White Space—'Language Becomes Possible And, By Becoming Possible, It Inspires Only A Silent And Immediate Communication' Somehow Outside All The Significations And Denotations]. The Same Reasoning Affects The Question Of Who Speaks—Individuals Or Language Itself In The Form Of Ideal Forms [And We Are Back With Greek Philosophy Examples. Socratic irony apparently Refers to the Fact That Individuals Both Initiate Speech and Are the Products of Speech—138. This In Turn Permits The Idea Of A 'Pure Rational Language… [Enabling]… Natural Communication between A Supremely Individuated God and the Derived Individuals Which He Created' (138)]. Further Irony Awaits The Romantic Notion Of The Person, 'The Finite Synthetic Unity Of The Person... [Not Just]... The Analytic Identity of the Individual' (138). Here, The Person And Representations Are Linked Ironically, Implying Both A Universal Idea And 'Sensible Particularity' (138), Both Universal And Particular Characteristics Of The Person—Hence The Earlier Argument That Persons Should Really Be Seen As A Class Which Has Only One Member. All These Formulations Assume That Singularities Are Located In The Individual Or The Person, Influenced Only By Some Groundless Abyss, Or Chaos, Threatening Both Classical And Romantic Discourse With The Lack Of Articulation. There Is Also A Threefold Division Of Language—The Ordinary Or Real; The Ideal Language, Like The Purely Rational One; Esoteric Language Which Subverts The Ideal Language And The Individuality Of The Speaker Of Ordinary Language [For Example Social Scientific Explanations, Or Structural Linguistic Ones?] [Weird Examples of Esoteric Languages Which Mean Nothing to Me on Page 140, With a Reference Back To Portmanteau Words]. So Sometimes Individual Speaks, Sometimes The Person, And Sometimes 'The Ground Which Dissolves Both' (140). The Only Way Out Is To See That Singularities Are Not Coterminous With Individuals, And There Is Not Just A Groundless Abyss Beneath Them. There Are Other Impersonal And Pre-Individual Singularities. Nonsense And Sense Collaborate At The Surface. Irony Gives Way To Humour—'The Co extensiveness Off Sense with Nonsense', A Matter Of 'Surfaces… Doubles… Nomad Singularities and Of the Always Displaced Aleatory Point' (141). Normal Significations, Denotations and Manifestations Are Suspended, and 'All Height and Depth Abolished' (141). Nineteenth Series of Humour. Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules Sixteenth Series Of The Static Ontological Genesis.Doctrines Come From 'Wounds And Vital Aphorisms' (148), And Some Writers See Themselves As Embodying Events [Hints Of The Stuff On Nietzsche And Illness Earlier]. Our Will Can Act As A Quasi Cause Of Bodily Events, As We Live Them. This Is An Ethical Stance—'Not To Be Unworthy Of What Happens To Us' (149). The Alternative Is Ressentiment. The Normal Moral Notions Such As Just Or Unjust Are Themselves Immoral. It Is Not Just A Matter Of Resignation To Events, Which Can Still Be Ressentiment, More An 'Apotheosis Of The Will' (149) [Citing Bousquet]. The Organic Is Exchanged For The Spiritual Will [Isn't This Just Making The Best Of Things, Finding Some Deep Meaning In Personal Tragedy?]. In This Sense, Freedom Is The Same As Submitting To Fate, Actualizing Events, Making Sense Of Events, Seeing Events As Something Expressed. One Becomes 'The Offspring of One's Events Are Not of One's Actions, For the Action Is Itself produced By the Offspring Of The Event' (150). In This Way, Actors Somehow Communicate With The Aion, Instead Of Being Dominated By Chronos. [Lots Of Implicit Christianity Here, Surely?]. All The Components Of An Event, Future As Well As Past, Are United, So That One Realises The Impact Of Singularities, Including Preindividual Components. [In This Way, Some Sort Of Agency Seems To Remain? One Can Become 'The Actor of One's Own Events – A Counter Actualization' (150)]. Ressentiment Arises From Not Realizing That Our Particular Part Of Experience, Which May Well Be Unjust, Is Part Of A More Perfect Whole. It Is Incorrect To Judge Everything From The Perspective Of The Present. Some Humourous Recognition of the Futility of It All Is Valuable—In the Great Scheme of Things, States of Affairs Are Always 'Impersonal and Pre-Individual, Neutral, neither General nor Particular' (151). In These Circumstances, Either Life Can Seem 'Too Weak For Me' [Not Vivid Enough, Not Enough Focused In The Present?], Or 'It Is I Who Am Too Weak For Life, It Is Life Which Overwhelms Me, Scattering Its Singularities All About, In No Relation To Me, Nor To A Moment Determinable As The Present Except An Impersonal Instant' (151). This Is Apparent When One Considers Death Or The Mortal Wound, An Event Which Is Indifferent To Me, 'Incorporeal And Infinitive, Impersonal, Grounded Only In It' (151), Although It Is I Who Has To Actualize The Event. However I Can Also Counter actualizes In the Sense Above. It Follows That The Events Of Reality Are Quite Different From Personal Experience, Shown In The 'Splendour Of The "They"… The Splendour of the Event Itself Order Of the Fourth Person' (152) [This Fourth Person Is the 'It' As In Phrases Like 'It Is Raining']. The Old Distinctions Between Private And Collective Refer Only To Personal Experience, Whereas 'Everything Is Singular, And Thus Both Collective And Private… Which Private Event Does Not Have All Its Coordinates, That Is, All Its Impersonal Social Singularities?' (152). Freedom Exists Only In Recognising The Impersonal Nature Of The Event, Seeing All Events As 'A Single Event Which No Longer Makes Room For The Accident, And Which Denounces And Removes The Power Of Ressentiment Within The Individual As Well As The Power Of Oppression Within Society' (152) [Ridiculous Philosophical Notion Of Freedom Overcoming Oppression By An Act Of Philosophy]. Ressentiment Ties One to an Oppressive Order. [Then A

Really Sentimental And Pathos Ridden Bit: ‘It Is At This Mobile And Precise Point, Where All Events Gather Together In One That Transmutation Happens: This Is The Point At Which Death Turns Against Death; Where Dying Is The Negation Of Death And The Impersonal At He Of Dying No Longer Indicates Only The Moment When I Disappear Outside Of Myself, But Rather The Moment When Death Loses Itself In Itself, And Also The Figure Which The Most Singular Life Takes On In Order To Substitute Itself For Me’ (153)] Ethics Links Logic and the Body. The Stoic Notion Of Bodies Included The Passions, And Good And Evil Intents: Particular Bodies Might Have Evil Mixtures, But The Aggregate Of Bodies Is Perfect Or Good, The Unity Of Causes Themselves. In Principle, Each Event Can Be Linked To A Particular Cause And Thus The Unity Of Causes, And This Could Lead To The Activity Of Divination [Grasping The Divine Unity Of Causes] As A Basis For Ethics. The Effects, Lines Have To Be Traced Back From Events To Pure Events And Then To Actions And Passions [With A Lot Of Poetic Stuff As Examples, 143]. Stoics Took Another Route To Ethics Through Logic [Kind Of Working Out Which Events Will Actualize]. Stoic Philosophy Then Saw In Representations Of The Limited Event A Connection With Pure Events [And Ethical Conduct Seems To Be To Work Towards Actualizing Such Events?]. [Stoic Accounts Of Representations Ensue, 144-5.] There Is A Difference [For Stoics] Between Representations Of Sense And Of Logic, Denotations And Significations, Representations And Expressions. Representation Is Not Just Resemblance, But Includes A Notion of Adequate Expression. Concepts Have To Be Actualised In Representation, And Also Expressed If They Are To Be Comprehensive. Thus Our Knowledge Of Death Is Abstract, Despite The Number Of Deaths We Witness, Until It Becomes Personal, Not Indifferent, But Concrete. This Is Where Expression Is Needed. In Stoic Philosophy, Moral Conduct Involves A Relation with Pure Events Unites Those Events with One's Self. [The Examples Again Come From Zen: 'The Bowman Must Reach The Point Where The Aim Is Also Not The Aim, That Is To Say, The Bowman Himself' (146).] An Understanding Of The Pure Event Is Required, As Something Which Is 'Eternally Yet To Come And Always Already Past', But Which Has To Be Willed Into Actualization (146). The Stoic Embodies Incorporeal Effects, Aligning Themselves With The Quasi Cause. It Is Necessary Because Quasi Causes Cannot Embody Themselves, Except To The Immediate Instant, The Present. [There Is An Equally Baffling Aside About The Difference Between Actors And Characters—Actors Represent By Occupying The Instant, While The Character Also 'Portrays Hopes Or Fears In The Future And Remembers Or Repents In The Past' (147). Stoics Therefore See Themselves As Uniting The Instant With The Unlimited Future And Past, Willing The Event And Also Representing It. [Largely Incomprehensible, Although I Am Starting To See How The Normal Notion Of Stoicism Might Fit—The Patient Resignation Of One's Self To One's Fate—And Also Seeing How Deleuze Thinks That Human Beings Should Reconcile Themselves To Solving The Problems That Reality Creates In The Form Of A Problematic]. Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules Sixteenth Series Of The Static Ontological Genesis. Deleuze And Guattari See In The Capitalist Money System “An Axiomatic Of Abstract Quantities That Keeps Moving Further And Further In The Direction Of The Deterritorialization Of The Socius” (Deleuze 1983a, 33), Which Is To Say That Capital Is Inherently Schizophrenic. However, Because Capital Also Re-Territorializes All Flows Into Money, Schizophrenia Remains Capitalism's External Limit. Nevertheless, It Is Precisely That Limit Against Which Thinking Can Subject Capitalism To Philosophical Critique. Psychoanalysis, They Say, Is Part Of The Reign Of Capital Because It Re-Territorializes The Subject As “Private” And “Individual,” Instituting Psychic Identity Through Images Of The Oedipal Family. However, The Oedipal Triangle Is Merely A Representational Simulacrum Of Kinship And Filiation, Re-Coded Within A System Of Debt And Payment. In This System, They Insist, Flows Of Desire Have Become Mere Representations Of Desire, Cut Off From The Body Without Organs And The Extra-Familial Mechanisms Of Society. A Radical Critique Of Capital Cannot Therefore Be Accomplished By Psychoanalysis, But Requires A Schizoanalysis “To Overturn The Theater Of Representation Into The Order Of Desiring-Production” (Deleuze 1983b, 271). Here, The Authors See A Revolutionary Potential In Modern Art And Science, Where, In Bringing About The “New,” They Circulate De-Coded And De-Territorialized

Flows Within Society Without Automatically Re-Coding Them Into Money (Deleuze 1983a, 379). In This Revolutionary Aspect, Anti-Oedipus Reads As A Statement Of The Desire That Took To The Streets Of Paris In May Of 1968, And Which Continues, Even Now, To Make Itself Felt In Intellectual Life. Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative For Models Kindly See One Of The Papers In The Series, Procrastinated Due To Restrictions On Space. The Term “Deconstruction,” Like “Postmodernism,” Has Taken On Many Meanings In The Popular Imagination. However, In Philosophy, It Signifies Certain Strategies For Reading And Writing Texts. The Term Was Introduced Into Philosophical Literature In 1967, With The Publication Of Three Texts By Jacques Derrida: Of Grammatology (English 1974), Writing And Difference (English 1978), And Speech And Phenomena (English 1973). This So-Called “Publication Blitz” Immediately Established Derrida As A Major Figure In The New Movement In Philosophy And The Human Sciences Centered In Paris, And Brought The Idiom “Deconstruction” Into Its Vocabulary. Derrida And Deconstruction Are Routinely Associated With Postmodernism, Although Like Deleuze And Foucault, He Does Not Use The Term And Would Resist Affiliation With “-Isms” Of Any Sort. Of The Three Books From 1967, Of Grammatology Is The More Comprehensive In Laying Out The Background For Deconstruction As A Way Of Reading Modern Theories Of Language, Especially Structuralism, And Heidegger's Meditations On The Non-Presence Of Being. It Also Sets Out Derrida's Difference With Heidegger Over Nietzsche. Where Heidegger Places Nietzsche Within The Metaphysics Of Presence, Derrida Insists That “Reading, And Therefore Writing, The Text Were For Nietzsche ‘Originary’ Operations,” (Derrida 1974, 19), And This Puts Him At The Closure Of Metaphysics (Not The End), A Closure That Liberates Writing From The Traditional Logos, Which Takes Writing To Be A Sign (A Visible Mark) For Another Sign (Speech), Whose “Signified” Is A Fully Present Meaning. This Closure Has Emerged, Says Derrida, With The Latest Developments In Linguistics, The Human Sciences, Mathematics, And Cybernetics, Where The Written Mark Or Signifier Is Purely Technical, That Is, A Matter Of Function Rather Than Meaning. Precisely The Liberation Of Function Over Meaning Indicates That The Epoch Of What Heidegger Calls The Metaphysics Of Presence Has Come To Closure, Although This Closure Does Not Mean Its Termination. Just As In The Essay “On The Question Of Being” (Heidegger 1998, 291-322) Heidegger Sees Fit To Cross Out The Word “Being,” Leaving It Visible, Nevertheless, Under The Mark, Derrida Takes The Closure Of Metaphysics To Be Its “Erasure,” Where It Does Not Entirely Disappear, But Remains Inscribed As One Side Of A Difference, And Where The Mark Of Deletion Is Itself A Trace Of The Difference That Joins And Separates This Mark And What It Crosses Out. Derrida Calls This Joining And Separating Of Signs Différance (Derrida 1974, 23), A Device That Can Only Be Read And Not Heard When Différance And Différence Are Pronounced In French. The “A” Is A Written Mark That Differentiates Independently Of The Voice, The Privileged Medium Of Metaphysics. In This Sense, Différance As The Spacing Of Difference, As Archi-Writing, Would Be The Gram Of Grammatology. However, As Derrida Remarks: “There Cannot Be A Science Of Difference Itself In Its Operation, As It Is Impossible To Have A Science Of The Origin Of Presence Itself, That Is To Say Of A Certain Non-Origin” (Derrida 1974, 63). Instead, There Is Only The Marking Of The Trace Of Difference, That Is, Deconstruction. Because At Its Functional Level All Language Is A System Of Differences, Says Derrida, All Language, Even When Spoken, Is Writing, And This Truth Is Suppressed When Meaning Is Taken As An Origin, Present And Complete Unto Itself. Texts That Take Meaning Or Being As Their Theme Are Therefore Particularly Susceptible To Deconstruction, As Are All Other Texts Insofar As They Are Conjoined With These. For Derrida, Written Marks Or Signifiers Do Not Arrange Themselves Within Natural Limits, But Form Chains Of Signification That Radiate In All Directions. As Derrida Famously Remarks, “There Is No Outside-Text” (Derrida 1974, 158), That Is, The Text Includes The Difference Between Any “Inside” Or “Outside.” A Text, Then, Is Not A Book, And Does Not, Strictly Speaking, Have An Author. On The Contrary, The Name Of The Author Is A Signifier Linked With Others, And There Is No Master Signifier (Such As The Phallus In Lacan) Present Or Even Absent In A Text. This Goes For The Term “Différance” As Well, Which Can Only Serve As A Supplement For The Productive Spacing Between Signs. Therefore, Derrida Insists That “Différance Is Literally Neither A Word Nor A Concept” (Derrida 1982, 3). Instead, It Can Only Be Marked As A Wandering Play Of Differences That Is Both A Spacing Of Signifiers In Relation To One Another And A Deferral Of Meaning Or

Presence When They Are Read. How, Then, Can Différance Be Characterized? Derrida Refuses To Answer Questions As To "Who" Or "What" Differs, Because To Do So Would Suggest There Is A Proper Name For Difference Instead Of Endless Supplements, Of Which "Différance" Is But One. Structurally, This Supplemental Displacement Functions Just As, For Heidegger, All Names For Being Reduce Being To The Presence Of Beings, Thus Ignoring The "Ontological Difference" Between Them. However, Derrida Takes The Ontological Difference As One Difference Among Others, As A Product Of What The Idiom "Différance" Supplements. As He Remarks: "Différance, In A Certain And Very Strange Way, (Is) 'Older' Than The Ontological Difference Or Than The Truth Of Being" (Derrida 1982, 22). Deconstruction, Then, Traces The Repetitions Of (e) The Supplement. It Is Not So Much A Theory About Texts As A Practice Of Reading And Transforming Texts, Where Tracing The Movements Of Différance Produces Other Texts Interwoven With The First. While There Is A Certain Arbitrariness In The Play Of Differences That Result, It Is Not The Arbitrariness Of A Reader Getting The Text To Mean Whatever He Or She Wants. It Is A Question Of Function Rather Than Meaning, If Meaning Is Understood As A Terminal Presence, And The Signifying Connections Traced In Deconstruction Are First Offered By The Text Itself. A Deconstructive Reading, Then, Does Not Assert Or Impose Meaning, But Marks Out Places Where The Function Of The Text Works Against Its Apparent Meaning, Or Against The History Of Its Interpretation. Postmodernism First Published Fri Sep 30, 2005 Copyright © 2005 By Gary Aylesworth Geaylesworth@Eiu.Edu Open Access To The SEP Is Made Possible By A World-Wide Funding Initiative For Models Kindly See One Of The Papers In The Series, Procrastinated Due To Restrictions On Space. "Anything Which Is (=) Just Born, Which Has (e) Just Come Into Existence, Has (e) No Past Behind It. Birth, In Other Words, Is (=) The Condition Of Having No Past. And Likewise, Anything Which Now Dies, Which Has Just Ceased To Be, Has No Future Left In Front Of It. Death Is The Condition Of Having No Future. But We Have Already Seen That This Present Moment Has Both No Past And No Future Simultaneously. That Is, Birth And Death Are One In This Present Moment. This Moment Is Just Now Being Born—You Can Never Find A Past To This Present Moment, You Can Never Find Something Before It. Yet Also, This Moment Is Just Now Dying — You Can Never Find A Future To This Moment, Never Find Something After It. This Present, Then, Is A Coincidence Of Opposites, A Unity Of Birth And Death, Being And Non-Being, Living And Dying. As Ippen Put It, "Every Moment Is The Last Moment And Every Moment Is A Rebirth." Ken Wilber, No Boundary: eastern and Western Approaches to Personal Growth for models please see one of the papers in the series. "Because We Demand A Future, We Live Each Moment In Expectation And Unfulfillment. We Live Each Moment In Passing. In Just This Way The Real Nunc Stans, The Timeless Present, Is Reduced To The Nunc Fluens, The Fleeting Present, The Passing Present Of A Mere One Or Two Seconds. We Expect Each Moment To Pass On To A Future Moment, For In This Fashion We Pretend To Avoid Death By Always Rushing Toward An Imagined Future. We Want To Meet Ourselves In The Future. We Don't Want Just Now—We Want Another Now, And Another, And Another, Tomorrow And Tomorrow And Tomorrow. And Thus, Paradoxically, Our Impoverished Present Is Fleeting Precisely Because We Demand That It End! We Want It To End So That It Can Thereby Pass On To Yet Another Moment, A Future Moment, Which Will In Turn Live Only To Pass." — Ken Wilber, No Boundary: Eastern And Western Approaches To Personal Growth. For Stoics, Causes Involved Reference To The Depths, But Effects At The Surface Could Also Have Relations Among Themselves. This Permitted The Distinction To Be Drawn Between Destiny And Necessity—The Stoics Wanted To Affirm Destiny And Deny Necessity. In The First Place, Effects Express Causes, But Expressions Of Relations [Rather Than Necessity] Connects Those Effects. Those Relations May Be Described As Compatibility Or Incompatibility, Conjunction Or Disjunction. These Are Not Causal Relations Themselves, But Represent 'An Aggregate Of Noncausal Correspondences Which Form A System Of Echoes, Of Presumptions And Resonances, A System Of Signs—In Short, An Expressive Quasi Causality And Not At All A Necessitating Causality' (170). This Need Not Involve Contradiction, Which Is Applying To Events Rules That Really Only Applied To Logic And Argument. There Can Be Incompatability Without Contradiction, A Noncausal Correspondence. Leibniz Described Incompossible Worlds [Delanda Is Very Clear On This Too]. Only Impossible Events Contradict Possible Ones. Events Can Be Compossible [Roughly, They Have Predictable And Predicative Future And Past Events]. For Deleuze, It Is A Matter Of 'The Convergence Of Series Which Singularities Of Events Form As They Stretch

Themselves Out Over Lines Of Ordinary Points. Incompossibility Must Be Defined By The Divergence Of Such Series' (171). Such A Notion Is Essential To Any Theory Of Sense. We Should Not See Divergence As A Matter Of Exclusion, As Leibniz Did [Since God Chose Actual Events]. Divergent And Disjunction Can Both Be Positive, While Preserving Differences. In Fact, Differences Are Crucial, Preserving The Distance Between Objects While Affirming That They Are Related. This 'Permits The Measuring Of Contraries Through Their Finite Difference Instead Of Equating Difference With A Measureless Contrariety' (173). It Is Contradiction Which Is The Special Case. Difference Here Is A Topological Term Relating To Distance On Surfaces Rather Than Depths. It Is Not Just A Matter Of Suggesting 'Some Unknown Identity Of Contraries (As In Commonplace In Spiritualist And Dolorist Philosophy)' (173) [Take That St Pierre!]. An Example Is Nietzsche Arguing That Health And Sickness Can Both Inform Each Other, Act As Points Of View, Remembering That 'Things, Beings, Are Themselves Points Of View' (173). Divergence Does Not Mean Exclusion, And Disjunction Does Not Mean Separation. Connective Syntheses '(If…, Then)' Construct A Single Series; Conjunctive Series '(And)' Produces Convergent Series, But Disjunctive Series '(Or)' Produces A Divergence Series. Normally, Disjunction Helps Us To Criticise Synthesis, But Disjunction Can Still Be A Synthesis Itself, Despite Its Use In Logical Analysis [I Think What Is Going On Here Is Arguing That There Is A Difference Between 'Either/Or' In A Logical Sense, And 'One Or Two' In The Real Sense—The Latter Can Mean That Both Are Compossible. This Is The 'Communication Of Events' Rather Than The Logical Business Of Analysing Predicates (174)]. The Synthetic Disjunction Expresses The Paradox, With Divergence At The Centre. The Discussion Of Paradoxes And Esoteric Words Above Are Examples: They Contract 'The Multitude Of Divergent Series In The Successive Appearance Of A Single One' (175). There Is A Difference Again Between The Subversion Of The Present And Simple Identity By Depths, And Operations At The Surface. By Considering The Depths, We Encounter Infinite Identities [As Events Become Examples Of Deeper Categories, Wholes?]. At The Surface Events Communicate With Each Other Directly Through Maintaining Distance And By Affirming Disjunctions. Disjunction Threatens The Identity Of The Self, And Helps Us To See The Self As 'So Many Impersonal And Pre-Individual Singularities' [Connected Through Disjunctive Synthesis. Hence The Importance Of Heterogeneity] (175). The Normal Concept Of The Self Implies Some Connected Series, 'But When Disjunction Accedes To The Principle Which Gives To It A Synthetic And Affirmative Value, The Self, The World, And God Share In A Common Death' (176). [There Is Also A Point That Divergent Series Explain And Also Exceed Normal Conjunctive And Connective Series]. In The Usual Conception, 'The Self Is The Principle Of Manifestation, In Relation To The Proposition, The World Is The Principle Of Denotation, And God The Principle Of Signification' (176). But The Theory Of Sense Here Says That It Emanates From Nonsense, From Paradox, And From The 'Eternally Decentred Ex-Centric Centre' (176). This Position 'Does Not Tolerate The Subsistence Of God As An Original Individuality, Nor The Self As The Person, Nor The World As An Element Of The Self And As God's Product. The Divergence Of The Affirmed Series Forms A "Chaosmos" And No Longer A World; The Aleatory Point Which Traverses Them Forms A Counterself, And No Longer A Self' (176). There Is No Centre But Only 'Pure Events Which The Instant, Displaced Over The Line[Of Aion] , Goes On Dividing Into Already Past And Yet To Come. Nothing Other Than The Event Subsists… This Communicates With Itself Through Its Own Distance And Resonates Across All Of Its Disjuncts' (176). Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper of the series, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules Sixteenth Series Of The Static Ontological Genesis Twenty-fourth series of the communication of events . "As Simple As That Sounds, It Is Nevertheless Extremely Difficult To Adequately Discuss No-Boundary Awareness Or Nondual Consciousness. This Is Because Our Language — The Medium In Which All Verbal Discussion Must Float — Is A Language Of Boundaries. As We Have Seen, Words And Symbols And Thoughts Themselves Are Actually Nothing But Boundaries, For Whenever You Think Or Use A Word Or Name, You Are Already Creating Boundaries. Even To Say "Reality Is No-Boundary Awareness" Is Still To Create A Distinction Between Boundaries And No-Boundary! So We Have To Keep In Mind The Great Difficulty Involved With

Dualistic Language. That "Reality Is No-Boundary" Is True Enough, Provided We Remember That No-Boundary Awareness Is A Direct, Immediate, And Nonverbal Awareness, And Not A Mere Philosophical Theory. It Is For These Reasons That The Mystic-Sages Stress That Reality Lies Beyond Names And Forms, Words And Thoughts, Divisions And Boundaries. Beyond All Boundaries Lies The Real World Of Suchness, The Void, The Dharmakaya, Tao, Brahman, The Godhead. And In The World Of Suchness, There Is Neither Good Nor Bad, Saint Nor Sinner, Birth Nor Death, For In The World Of Suchness There Are No Boundaries." ― Ken Wilber, No Boundary: Eastern And Western Approaches To Personal Growth. It Has Just Been Argued That Divergence Can Produce A Positive Synthesis, And That Ultimately, Events And States Of Affairs Are Compatible. Incompatibility Arises Only With Actualizations. It Is Individuals, For Example, Who Actualize Divergent Events. Even These Divergences Are Not Just Logical Contradictions But 'Alogical 'Incompatibilities. Persons Can Enjoy The Paradoxes That Ensue, But The Point Is How To Get To The Universal Communication Of Events, The Disjunctive Syntheses. Individuals Must Grasp Themselves As Events, And See What They Normally Regard As Themselves As An Actualization. Normal Individuality Is Only 'Fortuitous' (178). It Follows That The Same Thinking Must Be Extended To All Other Events And Individuals. 'Each Individual Would Be Like A Mirror For The Condensation Of Singularities… The Ultimate Sense Of Counteractualization' (178) [Undertaken For Cognitive Reasons Here Not Ethical Ones, Although Deleuze Says That This Is A Route To 'The Universal Freedom' (178)]. The Normal Sense Of The Individual As Having A Coherent Identity Must Be Replaced By The Notion Of A Series Of Individualities [With Nomadic Lines Connecting Them?]. We Then Get To The Realm Of Pure Events, And The Universal Connections Between Them, Seen As Disjunctive Syntheses Of Series, And The Knowledge That Actualized Events Are Fortuitous. [The Example Here Is That A Friend In One World Could Be An Enemy In Another Equally Possible World]. 'Philosophy Merges With Ontology, But Ontology Merges With The Univocity Of Being (Analogy Has Always Been A Theological Vision, Not A Philosophical One, Adapted To The Forms Of God, The World, And The Self)' (179). This Does Not Mean That There Is Only One And The Same Being [And Certainly Not Identical Beings, Because These Are Always Heterogeneous]. Instead, 'Being Is Voice That Is Said, And It Is Said In One And The Same "Sense" Of Everything About Which It Is Said' (179). It Is The Ultimate Form. All The Other Forms Remain 'Disjointed In It', But Being Joins Them Into Series And Disjunctions. 'The Positive Use Of The Disjunctive Synthesis… Is The Highest Affirmation... A Single Voice For Every Hum Of Voices And Every Drop Of Water In The Sea' (180). It Is Not Just That There Is A Connection At The Level Of Language—'Being Cannot Be Said Without Also Occurring' (180). In This Way, Event And Sense Are Identical. 'Univocal Being Is Neutral. It Is Extra Being, That Is The Minimum Of Being Common To The Real, The Possible And The Impossible… The Pure Form Of The Aion… One Single Event For All Events; One And The Same Aliquid [Something] For That Which Happens And That Which Is Said; And One And The Same Being For The Impossible, The Possible, And The Real' (180). Alexander I. Stingl's Blog A Nomadic Scholarship Entity NOTES ON: Deleuze, G (1990) The Logic Of Sense, Trans Mark Lester, Edited By Constantin Boundas, New York: Columbia University Press For Models Kindly See One Of The Papers In The Series. Attributable And Ascribable To Constraints On Space Accomodation Model Is Provided In Some Paper, Notwithstanding The Generality And Commonalty Of The Observation And Its Concatenatability With The Other Modules. Sāṅkhya (Often Spelled Sāṁkhya) Is One Of The Major "Orthodox" (Or Hindu) Indian Philosophies. Two Millennia Ago It Was The Representative Hindu Philosophy. Its Classical Formulation Is Found In Īśvarakṛṣṇa's Sāṅkhya-Kārikā (Ca. 350 C.E.), A Condensed Account In Seventy-Two Verses. It Is A Strong Indian Example Of Metaphysical Dualism, But Unlike Many Western Counterparts It Is Atheistic. The Two Types Of Entities Of Sāṅkhya Are Prakṛti And Puruṣa-S, Namely Nature And Persons. Nature Is Singular, And Persons Are Numerous. Both Are Eternal And Independent Of Each Other. Persons (Puruṣa-S) Are Essentially Unchangeable, Inactive, Conscious Entities, Who Nonetheless Gain Something From Contact With Nature. Creation As We Know It Comes About By A Conjunction Of Nature And Persons. Prakṛti, Or Nature, Is Comprised Of Three Guṇa-S Or Qualities. The Highest Of The Three Is Sattva (Essence), The Principle Of Light, Goodness And Intelligence. Rajas (Dust) Is The Principle Of Change, Energy And Passion, While Tamas (Darkness) Appears As Inactivity, Dullness, Heaviness And Despair. Nature, Though Unconscious, Is Purposeful And Is Said To Function For The Purpose Of The Individual Puruṣa-S. Aside From

Comprising The Physical Universe, It Comprises The Gross Body And "Sign-Body" Of A Puruṣa. The Latter Contains Among Other Things The Epistemological Apparati Of Embodied Beings (Such As The Mind, Intellect, And Senses). The Sign Body Of A Puruṣa Transmigrates: After The Death Of The Gross Body, The Sign-Body Is Reborn Into Another Gross Body According To Past Merit, And The Puruṣa Continues To Be A Witness Through Its Various Bodies. An Escape From This Endless Circle Is Possible Only Through The Realization Of The Fundamental Difference Between Nature And Persons, Whereby An Individual Puruṣa Loses Interest In Nature And Is Thereby Liberated Forever From All Bodies, Subtle And Gross. Much Of The Sāṅkhya System Became Widely Accepted In India: Especially The Theory Of The Three Guṇa-S; And It Was Incorporated Into Much Latter Indian Philosophy, Especially Vedānta. Internet Encyclopedia Of Philosophy Sankhya Author Information Ferenc Ruzsa Email: Ferenc.Ruzsa@Elte.Hu Eötvös Loránd University Hungary. The Amitabha Buddha Who Was, And Is, Revered And Praised By Buddhists Around The World, Radiates Indefinite Light And Life From This "State Of Cessation". This State Is A Continuous Process Of Calmness. It Will Be The Eventual Refuge For Us All. If We Think Carefully About The Definitions Of Calmness And Extinction, Then We Can Deduce That They Are The True Natural End-Points Of Rising And Falling. The True Nature Of The Cycle Of Rising And Falling Is Calmness And Extinction. Because Of This Nature, All Chaos And Conflicts In The State Of Rising And Falling Will Eventually Cease. This Is Attainable By The Realisation Of Prajna. Teachings In Chinese Buddhism (6) Sunyata (Emptiness) In The Mahayana Context (Wikipedia). Like Psychic DNA, The Collective Unconscious Contains "Inherited" Psychic Material That Links Us Not Only To Other Humans In The Present But Also To Our Ancestors From The Past. According To Jung's Theory, Though Each Of Us Appears To Function Independently, In Actuality We're All Tapped Into The Same Global Mind. Symbols Interact With And Condition Our Biohologram. The Collective Unconscious Is Essentially A Hologram. Symbols Arise From And Are Embedded In The Environment As Holographic Fields Of Energy. They Are Morphogenic Veils Of Primal Forces. If Your Brain Acts Like A Self-Contained Hologram, It Is Possible Your Consciousness Is Actually A Piece Of A Much Larger Hologram Of Overall Human Consciousness. Jung Noticed That Patterns Spontaneously Appear Over And Over Around The World. They Also Appear As Our Ancestral Memories Or Holographic Wisdom Field. In The Archetypal World, Everyone Is The Same, All Around The World... We Are All Gods, And Our Emotional Addictions To Pain And Suffering, Contempt, Insecurities, Doubt, Failure, Is Holographically-Recorded And Can Be Holographically Healed. All Archetypes Are A Form Of Human Expression That Is Both Holographic And Physical. Physical Formations Of Archetypal Sequences Cause Humans To Behave In Parallel Manners To Each Ancestor That Is Associated. Integration Is A Function Of Intentionality -- Conscious And Unconsciously Maintained, Or Incorporated. Integration Occurs Both Without Effort, As A Redesign Of The Central Processor Of Our Minds, And Voluntarily As A Deliberate Effort To Understand, Find Meaning, And As Rectification Of Our Behavior Towards Others And Towards Ourselves. Imagination Is Structured By The Archetypal Potentials Of The Unconscious. Archetypes Structure The Possibility To Generate And Entertain Such Ideas. The Archetype Itself Cannot Be Known But Structures Everything We Come To Know. Their Totality Functions As A Psychic Organ. Universal Themes Appear In Distinct Cultural Garb. Over Millennia, All The Archetypes Have Emerged In Stories, Deities And Cultural Forms. One Of The Striking Points Of Religious Faith Is That They Aren't True. In Early History People Didn't Know The 'Real' Reasons Things Happened, So It's No Surprise That Their Explanations Were Wrong. But Then, Why Would We Want To Retrieve Such Superstitions? Kuhn Reminds Us That Even The Most Absurd Or Confused Explanation Of A Phenomenon Can Find Acceptance In The Absence Of A Competing Idea. Once Any Explanation Is Offered For A Phenomenon, It Has An Explanation From That Time On. Succeeding Speculations Might Be Able To Explain The Relevant Phenomena Better Than Its Predecessors. Deities, As Archetypal Role Models, Are The Opening Gambit In The Drama Of Understanding Human Subjectivity. Folk Tales Function The Same Way. Deities Or Archetypes May Have Evolved To Smooth Interpersonal Relations By Including An Understanding Of Human Types, Along With Rules For Helping The Different Types Relate With One Another. They Are Reflections Of Ancient Evolutionary Pressures, With A Dash Of Neuroanatomy. We Still Have Yjr Same Pressures Today So The Ancient Archetypes Still "Work", Regardless Of Objective Existence Of Gods And Goddesses. Burke (2003) Describes How The Underlying Pattern Or Strange Attraction Between

Transference And Holography Extends To Other Processes Both Within And Outside The Field Of Psychology. Such Processes Include Projection, Projective Identification, Splitting, Memory, Biology, Creative Discovery, Theology, Synchronicity, Chaos, And Nonlocality. Identifying The Similar Patterns Of These Processes Demonstrates The Existence Of An Underlying Holographic Archetype In Which Essential Qualities Of The Whole Are Present In Each Of The Parts Of The Whole. The Autonomy Of The Overall Human Is Present In Each Conscious And Unconscious Component Part Of The Human Psyche. Cognition, Itself Is A Holographic Archetype. Many Essential Qualities Of The Whole Are Reflected Or Contained In Each Of The Parts That Make Up That Whole. It Is A Subtle Net Of Metaphor, Analogy And Simile. Holographic Archetypes Effectively Echo Their Resonant Patterns Through Literal And Symbolic Reflectaphors. The Passing Forms Of The Holographic Archetype Include The Hologram, Psychic Structure, Synchronicity, Wisdom Traditions, Memory, And The Process Of Scientific Discovery, Chaos In Physics, Nonlocality And Virtuality In Physics. As Unconscious Structuring Principle, The Archetype Lies Beyond Normal Consciousness And Emerges Suddenly And Dynamically From The (Holographic) Psychoid Field, With A Powerful Emotional Charge That Invests It With Significance. Everything That Happens Is Conditioned By The Moment In Which It Happens. The Universal Field Imposes The Conditions. Matter Is Not Inert But Receptive To Holistic Patterning. If The Mythic World Taught Our Ancestors How To Manipulate The Empirical World, It Also Taught Them To Manipulate That Mythic Narrative Itself For Control Purposes. Socioeconomic Power Enforces Its Mythic Narrative. The Psychoid Field Imposes Holistic Function. Autonomous Inner Forces Arouse Compelling Opportunities To Enact Archetypal Behaviors. They Guide Our Perceptions And Behavior, Usually Without Our Awareness. Limbic Action Of Complexes Is A Big Part Of The Holistic Dynamics Of The Psyche. Dreams Report What Goes On Beneath The Veil Of Conscious Awareness. To The Consciousness Of The 'Thinker', Knowledge Is Thought. Period. Without Thought, The Consciousness Of The 'Thinker' Collapses Into Psychosis. With Archetypes Come The Potential For Wisdom, Relatedness, Sociality, Ambiguity, Paranoia, Projection, Identification, Denial, Inflation, Sub Personalities (Fragmentation), Defensiveness, Obsession, Hypnotic Dissociation, The Contagion Of Participation Mystique, Mythologizing, Complexes, Compensation, And Self-Delusion. Compensation May Calm Or Disturb Consciousness. There Is No Imperative For The Ego To Integrate These Alternative Perspectives, Private And Public Myths. The Unconscious Can Produce Deep Wisdom And Utter Nonsense. It Is Up To The Ego To Discriminate. The Value Of Myths Is Purely Heuristic, Not Pragmatic. Jung In The 21st Century: Synchronicity And Science By John Ryan Haule Mind Control Countermeasures. Forms Of Experience, Such As Madness, Violence, Or Sexuality That Break From The Prison Of Rationality. Where Modern Societies "Problematize" Forms Of Experience Such As Madness, Illness, And Sexuality, That Is, Turn Them Into Governmental Problems, Into Areas Of Life In Need Of Control And Regulation, Foucault In Turn Queries The Social Construction Of “Problems” By Uncovering Their Political Motivations And Effects And By Challenging Their Character As Natural, Necessary, Or Timeless. In What He Calls A "Diagnostic Critique" That Combines Philosophy And History (1989: 38-39, 73), Foucault Attempts To Clarify The Nature Of The Present Historical Era, To Underline Its Radical Difference From Preceding Eras, And To Show That Contemporary Forms Of Knowledge, Rationality, Social Institutions, And Subjectivity Are Contingent Socio-Historical Constructs Of Power And Domination, And Therefore Are Subject To Change And Modification. Foucault's Ultimate Task, Therefore, Is "To Produce A Shift In Thought So That Things Can Really Change" (Quoted In O'Farrell 1989: 39). The Goal Of Foucault's Historico-Philosophical Studies, As He Later Came To Define It, Is To Show How Different Domains Of Modern Knowledge And Practice Constrain Human Action And How They Can Be Transformed By Alternative Forms Of Knowledge And Practice In The Service Of Human Freedom. Foucault Is Concerned To Analyze Various Forms Of The "Limit Experience" Whereby Society Attempts To Define And Circumscribe The Boundaries Of Legitimate Thought And Action. The Political Vision Informing Foucault's Work Foresees Individuals Liberated From Coercive Social Norms, Transgressing All Limits To Experience, And Transvaluing Values, Going Beyond Good And Evil, To Promote Their Own Creative Lifestyles And Affirm Their Bodies And Pleasures, Endlessly Creating And Recreating Themselves. Foucault Denies There Can Be Any Basis For Objective Descriptive Statements Of Social Reality Or Universal Normative Statements That Are Not Socially Conditioned And Locally Bound. He Tries To Show That All Norms, Values, Beliefs, And Truth

Claims Are Relative To The Discursive Framework Within Which They Originate. Any Attempt To Write Or Speak About The Nature Of Things Is Made From Within A Rule-Governed Linguistic Framework, An "Episteme," That Predetermines What Kinds Of Statements Are True Or Meaningful. All Forms Of Consciousness, Therefore, Are Socio-Historically Determined And Relative To Specific Discursive Conditions. There Is No Absolute, Unconditioned, Transcendental Stance From Which To Grasp What Is Good, Right, Or True. Foucault Refuses To Specify What Is True Because There Are No Objective Grounds Of Knowledge; He Does Not State What Is Good Or Right Because He Believes There Is No Universal Standpoint From Which To Speak. Universal Statements Merely Disguise The Will To Power Of Specific Interests; All Knowledge Is Perspectival In Character. For Postmodern Theorists Like Foucault, The Appeal To Foundations Is Necessarily Metaphysical And Assumes The Fiction Of An Archimedean Point Outside Of Language And Social Conditioning. Habermas (1987) Rightly Finds Perplexing An Approach That Raises Truth Claims While Destroying A Basis For Belief In Truth, Which Takes Normative Positions While Suppressing The Values To Which They Are Committed. For Critique To Be Justified And Effective, It Should Preserve Standards By Which To Judge And Evaluate, But Foucault's Total Critique Turns Against Itself And Calls All Rational Standards Into Question. **Richard Rorty, The Attack On Theory, And Renunciation Of Radical Politics.** Deleuze's Analysis Begins by Coming to New Understandings of the Concepts of the Image and Movement. The Image, Above All, Is Not A Representation Of Something, That Is, A Linguistic Sign. This Definition Relies Upon The Age-Old Platonic Distinction Between Form And Matter, In Its Modern Saussurean Form Of Signifier-Signified. Rather, Deleuze Wants To Collapse These Two Orders Into One, And The Image Thus Becomes Expressive And Affective: Not An Image Of A Body, But The Body As Image (C1 58). This Collapse Comes About With Reference To Two Philosophers, Henri Bergson And Charles Sanders Pierce. Deleuze Dedicated A Book-Length Study To The Former Entitled Bergsonism (1968), And His Use Of His Notions Of Movement And Time In The Cinema Texts Is Already Presaged By This Text. Movement For Bergson, Deleuze Argues, Is Not Separable From The Object Which Moves: (I Am Not Movement: Italics Mine) They Are Literally The Same Thing. Thus, No Representative Relationship Can Be Established Without Artificially Halting The Flow Of Movement And Thus Misconstruing The Frozen 'Element' As Self-Sufficient. (See the befuddling similarity of holographic principle of Modern Quantum Mechanics and the Deleuzean idea; italics mine) There Is Only The Flow Of Movement Which Expresses Itself In Different Ways. Among Other Things, This Is One Of Deleuze's Critiques Of Phenomenology (C1 56, 60). Thus The Early Cinema Is Characterised For Deleuze By The Reign Of What He Calls The Sensory-Motor Schema. This Schema Is The Unity Of The Viewed And The Eye That Views In Dynamic Movement. This Model Of The Movement-Image Is Precisely The Nature Of Cinema, For Deleuze. It Does Not Falsify Movement By Extracting Segments And Stringing Them Together In A Representative Fashion, But Creates A Wide Range Of Expressive Images. It Is In Order To Come To Terms With The Varieties Of Movement-Images That Deleuze Turns To Pierce, Who Developed, "The Most Extraordinary Classifications Of Images And Signs . . ." (C2 30). …………. With Some Alterations, Pierce's Semiotic Classifications To Describe The Use Of Movement-Images In Cinema, And Their Centrality Before The Second World War The Movement From The First Text To Cinema 2: The Time-Image Has A Significance Closely Related To Kant's So-Called Copernican Revolution In Philosophy. Up Until Kant, Time Was Subject To The Events That Took Place Within It, Time Was A Time Of Seasons And Habitual Repetition (See (3) (C) Above); It Was Not Able To Be Considered On Its Own, But As A Measure Of Movement (C2 34-5; KCP Iv.). One Element Of Kant's Achievement For Deleuze, As We Have Seen, Is His Reversal Of The Time-Movement Relationship: He Establishes Time Itself As An Element To Which Movement Must Be Subordinated, A Pure Time. In The Cinema, Deleuze Argues, A Similar Reversal Takes Place. The Historico-Cultural Reason Behind This Reversal Is The Event Of World War Two Itself. With The Great Truths Of Western Culture Put So Deeply In Question By The Before Unimaginable Methods Employed And Their Forthcoming Results, The Sensory-Motor Apparatus Of The Movement-Image Are Made To Tremble Before The Unbearable, The Too-Much Of Life's Possibilities, The Potential Of The Present (C2 35). No Longer Could The Dogmatic Truths That Had Guided Society, And Cinema To An Extent, Allow The Apparently 'Natural' Movement From One Thing To The Next In An Habitual Fashion: 'Natural' Links Precisely Lost Their Efficacy. And With The Use Of Unnatural Or False Links, Which Do Not Follow The Sequence Or Narrative Affect Of The Movement-

Image, Time Itself, The Time-Image, Is Manifested In Cinema (Deleuze Considers Orson Welles To Be The First Auteur To Make Use Of The Time-Image (C2 137)). Rather Than Finding Time As An, "Indirect Representation," (C2 35-6), The Viewer Experiences The Movement Of Time Itself, Which Images, Scenes, Plots And Characters Presuppose Or Manifest In Order To Gain Any Sort Of Movement Whatsoever. Along With This 'External' Reason, There Is Also For Deleuze A Motivation Within Cinema Itself To Go From The Movement-Image To The Time-Image. The Movement Image Has The Tendency, Thanks To The Habitual Experience Of Movement As Normal And Centered, To Justify Itself In Relation To Truth: As Deleuze Argues With Regard To The Dogmatic Image Of Thought (See (3)(D) Above), There Is The Presupposition That Thought Naturally Moves Towards Truth. Of Course, Deleuze Suggests, Cinema, When Truly Creative, Never Relied Upon This Presupposition, And Yet, "The **Movement-Image, In Its Very Essence, Is (=) Answerable To (e) The Effect Of (e) Truth Which It Invokes (e&eb) While Movement Preserves (eb) Its Centres." (C2 142).** In Questioning Its Own Presuppositions, Deleuze Argues, **Cinema Moved Towards A New, Different, Way Of Understanding Movement Itself, As Subordinate To (e) Time. (Wikipedia: Gilles Deleuze).** From His Early Writings On, Nietzsche, Like Kierkegaard, Rails Against A Life-Denying (e) Rationalism And Idealist Philosophy Which Champions' Reason Over The Passions. Nietzsche Interprets The "Subject" As A Mere Construct, An Idealized Sublimation Of Bodily Drives, Experiences, And (e&eb) A Multiplicity Of Thoughts And Impulses. This "Little Changeling," On Nietzsche's View, This Subject, "Is Believed in (eb) More Firmly than Anything Else on Earth," But Is For Him A Simple Illusion Created Out Of (e) Modern Desperation To Have (e) A Well-Grounded Identity. Belief In The Subject Is Promoted By The Exigencies Of (e) Grammar Which Utilize A Subject/Predicate Form, Giving Rise To (eb) The Fallacy That The "I" Is A Substance, Whereas It Is (=) Really Only A Convention Of Grammar (Nietzsche 1968b: 37-38). For Nietzsche, "The Doer" Is (=) "Merely A Fiction Added To The Deed -- The Deed Is (=) Everything" (1968b: 45). "The **Subject**," He Concludes, Is (=) Thus But A Shorthand Expression For (e) A Multiplicity Of Drives, Experiences, And Ideas. In The Spirit Of Enlightenment, Nietzsche Also Polemicizes Against (e&eb) Metaphysics, Arguing That It Illicitly Generalizes From (e) Ideas In One Historical Epoch To (e) The Entirety Of History. Against This Form Of (e) Philosophical Universalism, Nietzsche Argues "**There Are (=) No Eternal Facts, Just As There Are (=) No Absolute Truths.** Consequently, What Is Needed From Now On Is (=) Historical Philosophizing, And With It (eb) The Virtue Of Modesty" (Nietzsche 1986: 13). Castigating Traditional Philosophy And Values From (e) A Critical Enlightenment Perspective, Nietzsche Anticipates Later Postmodern Critiques Of Metaphysics, Assailing (e) The Concept Of Enduring Knowledge, The Notion Of A Transcendental World, And Presenting (eb) Metaphysical Thought As (=) A Thoroughly Obsolete Mode Of (e) Thinking. He Attributes The "Metaphysical Need," At (eb)The Heart Of Philosophies Such As (=) Schopenhauer's, To Primitive Yearnings For Religious Consolation For (e) The Sufferings Of Life And He Urges "Free Spirits" To Liberate Them And Pursue (e&eb) Thinking And Living Experimentally (1986: 8). Nietzsche's Attack On Foundationalism, Universalizing Thought, And Metaphysics Thus Undertakes (e&eb) A "Postmodern" Turn In Philosophy Through (e&eb) A Radical Deconstruction Of (e) Modern Theory. But While Deconstructionist Philosophies Typically Terminate (e) In The No, Merely Seeking To (e) Unravel A Positive Modern Value System Into (e&eb) A Heap Of Disconnected Fragments, Nietzsche Starts And Finishes With (e&eb) A Big Yes, A Life-Affirming Value, Deconstructing Only To (e) Reconstruct. Moving Far Away From Schopenhauerian Pessimism, Back Toward (e&eb) A Greek View Of Tragedy, Toward A Dionysian View Of Existence, Nietzsche Seeks "A Justification Of Life, Even At Its Most Terrible, Ambiguous, And Mendacious" (1968a: 521), A Justification Found In Art, Creativity, Independence, And The Emergence Of (e) "Higher Types" Of Humanity. Yet Nietzsche's Perspectivism Denies (e) The Possibility Of (e) Affirming Any Absolute Or Universal Values: All Ideas, Values, Positions, And So On Are Posits Of Individual Constructs Of A Will To Power, Which Are To Be Judged According To (e&eb)The Extent To Which They Do Or Do Not Serve The Values Of Life, Creativity, And Strong Individuality. For Nietzsche There Are (=) No Facts, Only (e&eb) Interpretations, And He Argues That All Interpretation Is Constituted By(e) The Individual's Perspectives And Is Thus Inevitably Laden With (e&eb) Presuppositions, Biases, And Limitations. For Nietzsche, A Perspective Is (=)Thus An Optic, A Way Of Seeing, And The More Perspectives One Has At One's Disposal, The More One Can See, And The Better One Can Understand And Grasp Specific Phenomena. To Avoid Limited And Partial Vision

One Should Learn "How To Employ A Variety Of Perspectives And Interpretations In The Service Of Knowledge" (Nietzsche 1968a: 119). THE POSTMODERN TURN IN PHILOSOPHY: THEORETICAL PROVOCATIONS AND NORMATIVE DEFICITS By Steven Best And Douglas Kelner Http://Www.Gseis.Ucla.Edu/Faculty/Kellner/Kellner.Html. And Just As During Much Of The Twentieth Century, Any Plea For Greater Social Justice Could Be Successfully Damned As Communist, Likewise Today, Any Strategy To Eradicate Suffering Is Likely To Be Condemned In Similar Reactionary Terms: Either Wire Head Hedonism Or Revamped Brave New World. This Response Is Not Just Facile And Simplistic. If It Gains Currency, The Result Is Morally Catastrophic. Of Course, The Abolitionist Issue Rarely Arises. Typically, Universal Bliss Is Still More-Or-Less Unthinkingly Dismissed As Technically Impossible. Insofar As The Prospect Is Even Contemplated - Grudgingly - It Is Usually Assumed That The New Regime Would Be Underwritten Day-By-Day With Drugs Or, More Crudely, Electrodes In The Pleasure-Centres. These Techniques Have Their Uses. Yet In The Medium-To-Long-Term, Stopgaps Won't Be Enough. All Use Of Psychoactive Drugs May Be Conceived As An Attempt To Correct Something Pathological With One's State Of Consciousness. There's Something Deeply Wrong With Our Brains. If What We Had Now Was OK, We Wouldn't Try To Change It. But It Isn't, So We Do. Mature Biological Psychiatry Will Recognise Inadequate Innate Bliss As A Pandemic Form Of Mental Ill-Health: Good For Selfish DNA In The Ancestral Environment Where The Adaptation Arose, But Bad For Its Throwaway Vehicles, Notably Us. The Whole Gamuts Of Behavioural Conditioning, Socio-Economic Reform, Talk-Therapies - And Even Euphoriant Superdrugs - Are Just Palliatives, Not Cures, For A Festering Global Illness. Its Existence Demands A Global Eradication Program, Not Idle Philosophical Manifestos And Scientific Belle's Letters. But One Does One's Best. The Ideological Obstacles To Genetically Pre-Programmed Mental Super-Health Are Actually More Daunting Than The Technical Challenges. To Be Cured, Hypo-Hedonia Must Be Recognised As A Primarily Genetic Deficiency-Disorder. Designer Mood-Brighteners And Anti-Anxiety Agents To Alleviate It Are Sometimes Branded "Lifestyle-Drugs"; But This Is To Trivialize A Serious Medical Condition Which Must Be Corrected At Source. Happily, Our Hereditary Neuropsychiatric Disorder Is Likely To Become Extinct Within A Few Generations As The Reproductive Revolution Unfolds. Aversive Experience, And The Poisonous Metabolic Pathways That Mediate Its Textures, Will Become Physiologically Impossible Once The Genes Coding Its Neural Substrates Have Been Eliminated. We Won't Miss Its Corrupting Effect When It's Gone. In The Medium-Term, The Functional Equivalent Of Aversive Experience Can Help Animate Us Instead. Late In The Third Millennium And Beyond, Its Functional Successors May Be Expressed As Gradients Of Majestic Well-Being. On This Scenario, Our Descendants Will Enjoy A Civilisation Based On Information-Bearing Pleasure-Gradients: Whether Steep Or Shallow, We Simply Don't Know. Such A Global Species-Project Does Not Have The Desperate Moral Urgency Of Eliminating The Phenomenon Of Darwinian Pain - Both "Mental" And "Physical", Human And Non-Human Alike. Abolishing Raw Nastiness - Sometimes Vile Beyond Belief - Remains The Over-Riding Ethical Priority. One Doesn't Have To Be An Outright Negative Utilitarian To Acknowledge That Getting Rid Of Agony Takes Moral Precedence Over Maximizing Pleasure. But Both Genetic Fundamentalists And Gung-Ho Advocates Of Better Living Through Chemistry Today Agree On One Crucial Issue. There Is No Sense In Sustaining A Legacy Of Mood-Darkening Metabolic Pathways Out Of Superstitious Deference To Our Savage Past. When Bernard Marx Tells The Savage He Will Try To Secure Permission For Him And His Mother To Visit The Other Place, John Is Initially Pleased And Excited. Echoing Miranda In The Tempest, He Exclaims: "O Brave New World That Has Such People In It." Heavy Irony. Like Innocent Miranda, He Is Eager To Embrace A Way Of Life He Neither Knows Nor Understands. And Of Course He Comes Unstuck. Yet If We Swallow Such Fancy Literary Conceits, Then Ultimately The Joke Is On Us. It Is Only Funny In The Sense There Are "Jokes" About Auschwitz. For It Is Huxley Who Neither Knows Nor Understands The Glory Of What Lies Ahead. A Utopian Society In Which We Are Sublimely Happy Will Be Far Better Than We Can Presently Imagine, Not Worse. And It Is We, Trapped In The Emotional Squalor Of Late-Darwinian Antiquity, Which Neither Know Nor Understand The Lives Of The God-Like Super-Beings We Are Destined To Become. **A Defence Of Paradise-Engineering Brave New World By Aldous Huxley Brave New World (1932) Is One Of The Most Bewitching And Insidious Works Of Literature Ever Written.** . Deleuze attacks Hegel and others in what we can call—though Deleuze did not—the "identitarian" tradition first of all by means of (e) a radicalized reading of Kant, whose genius, as Deleuze explains in Kant's Critical Philosophy (1963), was to have conceived of a purely immanent critique of reason—a critique that did not seek "errors" of reason produced by external causes, but rather "illusions" that arise (eb) from within reason itself by the illegitimate (transcendent) uses of the syntheses of (e) consciousness. Deleuze characterized his own work as a philosophy of immanence, arguing that Kant himself had failed to realize fully the ambitions of his critique, for at least two reasons: first, the failure to pursue a fully immanent critique, and second, the failure to propose a genetic account of (e) real experience, resting content with the account of the conditions of possible experience. First, Kant made the field of consciousness immanent to (e) a transcendental subject, thereby reintroducing an element of identity that is (=) transcendent (that is, external) to (e) the field itself, and reserving all power of synthesis (that is, identity-formation) in the field to the activity of (e) the always already unified and transcendent subject. (Deleuze was influenced in this regard by his reading of Sartre's 1937 essay "The Transcendence of the Ego.") Already in his Hume book, Empiricism and Subjectivity (1953), Deleuze had pointed to an empiricist reversal of Kant. Where Kant's question had been "How can the given be given to (e) a subject?" Hume's question had been "How is the subject (human nature) constituted within (eb) the given?" Metz asserting a notion of langue with the formal elements associated with narrative. Moreover he narrowed this gap further by claiming a version of langue's syntagmatic and paradigmatic in the operation of cinematic narrative. Deleuze notes the significance of this move in The Time-Image: [L]anguage features which necessarily apply to utterances will be found in the cinema, as rules of use, in the language system and outside of it: the syntagm (conjunction of present relative units) and the paradigm (disjunction of present units with comparable absent units). The semiology of the cinema will be the discipline that applies linguistic model, especially syntagmatic ones, to images as constituting one of their principle "codes" (25-26). (As quoted in Roger Dawkin's making matter our of Deleuzean concept of cinema) An exemplary and illustrious account of unbounded consciousness has been studied by CORRINA BONSHEK Deleuzian sensation and unbounded consciousness in Anna & Corrina Bonshek's Reverie I (2002). Entire article has been modelled in one of the paper in the series. It is true that Deleuze sometimes suggests follow of the Model and Shadow theme instead of getting into the trap of consciousness and cogito. This should not be confused with the unbounded consciousness Deleuze mentioned in his studies on Cinema. In his mature work, Deleuze argues for an "impersonal and pre-individual" transcendental field in which the subject as identity pole which produces (eb) empirical identities by active synthesis is itself the result or product of (e) differential passive syntheses (for instance, in what Deleuze calls the syntheses of habit, we find bodily, desiring, and unconscious "contractions" which unify (e&eb) a series of experiences, extracting (eb) that which it to be retained in the habit and allowing (eb) the rest to be "forgotten"). The passive syntheses responsible for subject formation must be qualified as (=) "differential," for three reasons. Each passive synthesis is (=) serial, never singular (there is never one synthesis by itself, but always a series of (e) "contractions," that is to say, experience is (=) ongoing and so our habits require (e) constant "updating"); each series is related to (e&eb) other series in the same body (at the most basic level, for instance, the series of taste contractions is related to (e&eb) those of smell, sight, touch, hearing and proprioception); and each body is related to (e&eb) other bodies, which are themselves similarly differential (the series of syntheses of bodies can resonate or clash). Together the passive syntheses at all these levels form (eb) a differential field within which subject formation takes place as (=) an integration or resolution of that field; in other words, subjects are (=) roughly speaking the patterns of (e) these multiple and serial syntheses which fold in on themselves producing (eb) a site of self-awareness. Of course, Deleuze never simply proclaims this as a bald thesis, but develops a genetic account of subjectivity in many of his books. Taking all this into account, Deleuze summarized his differential, immanent and genetic position by the at first glance odd phrase of "transcendental empiricism." This is cashed out in terms of two characteristics: (1) the abstract (e.g., "subject," "object," "State," the "whole," and so on) does not explain, but must itself be (=) explained; and (2) the aim of philosophy is not to rediscover (eb) the eternal or the universal, but to find the singular conditions under which (e&eb) something new is produced. In other words—and this is a pragmatic perspective from which Deleuze never deviated—philosophy aims not at stating the conditions of knowledge qua representation, but at finding and fostering (eb) the conditions of creative production. Deleuze's second criticism of Kant claims that he had simply presumed (eb) the existence of knowledge and morality as "facts" and then sought their conditions of possibility in the transcendental But already in 1789, Salomon Maimon, whose early critiques of Kant helped generate the post-Kantian tradition, had argued that Kant's critical project required (e) a method of genesis—and not (e) merely a method of conditioning—that would account for the (eb) production of knowledge, morality, and indeed reason itself. In other words, Maimon called for a genetic method that would be able to reach (eb) the conditions of real and not merely possible experience. Maimon found a solution to this problem in a principle of difference: whereas identity is (=) the condition of possibility of thought in general, it is difference that constitutes (e) the genetic and productive principle of real thought. These two Maimonian exigencies—the search for the genetic conditions of real experience and (e&eb) the positing of a principle of difference—appear in almost every one of Deleuze's early monographs. Nietzsche and Philosophy (1962), for instance, suggests that Nietzsche completed and inverted Kantianism by bringing critique to bear, not simply on false claims to knowledge or morality, but on (eb) true knowledge and true morality, and indeed on truth itself: "genealogy" constituted (e) Nietzsche's genetic method, and the will-to-power was (=) his principle of difference. Deleuze's anti-Hegelianism is shown in his focus on (eb) the productivity of the non-dialectical ("affirmative") differential forces termed by Nietzsche "noble." These forces affirm themselves, and thereby differentiate (e&eb) themselves first, and only secondarily consider that from which they have (e) differentiated themselves. In Bergsonism (1966), Deleuze develops the ideas of virtuality and (e&eb) multiplicity that will serve as (=) the backbone of his later work. From Maimon's reading of Kant, we know that Deleuze needs to substitute the notion of the condition of the genesis of the real for (e&eb) the notion of conditions of possibility of representational knowledge. The positive name for that genetic condition is the virtual, which Deleuze adopts from the following Bergsonian argument. The notion of the, possible Bergson holds in Creative Evolution, is derived from (e) a false problem that confuses the "more" with (e&eb) the "less" and ignores (e) differences in kind; there is not less but more in (eb) the idea of the possible than in the real, just as there is (=) more in the idea of nonbeing than in that of being, or more in the idea of disorder than (e) in that of order. When we think of the possible as (=) somehow "pre-existing" the real, we think of (e) the real, then we add to (e) it the negation of its existence, and then we project (e&eb) the "image" of the possible into the past. We then reverse the procedure and think of the real as (=) something more than possible, that is, as the possible with existence added to (e) it. We then say that the possible has been "realized" in (eb) the real. By contrast, Deleuze will reject the notion of the possible in favor of (e) that of the virtual. Rather than awaiting realization, the virtual is (=) fully real; what happens in genesis is (=) that the virtual is (=) actualized. The fundamental characteristic of the virtual, that which means (eb) it must be actualized rather than realized, is its differential makeup. Here Deleuze used terms actualisation and realisation as if they are (=) differential in nature Actualisation of the dreams could be tantamount to (=) the realization of the dreams, but the reciprocal is not true. (My interpretation) Deleuze always held the critical axiom that the ground cannot (e) resemble that which it grounds; he constantly critiques the "tracing" operation by which identities in real experience are said to be conditioned (e&eb) by identities in the transcendental. Mention may be made of the Deleuzian statement that the relationship between problem and its conditions bears ample testimony and infallible observatory to the truth of the problem as such. Deleuze writes: ……….as for the determination of the conditions it implies (eb) on one hand, a space of nomadic distribution, in which singularities are (=) distributed, on the other hand, it implies, (eb) a time of decomposition whereby a space is (=) subdivided in to subspaces. (See Seventeenth series of Logical genesis: Gilles Deleuze: Translation by Constantin Boundas) **It is to be noted that Deleuze writes in a progressive vein; and the subspaces he mentions are those which incorporate adjunct and corresponding points, which in fact defines progressively a determined domain under consideration.** This also brings us to the question whether there is any space which has singularities in its domain under consideration, and if so effects of such singularities incorporated thereof the space itself. Modem quantum mechanics proves beyond doubt that the happenings in space affect the space and vice versa. Deleuze goes on to state that verily there is a space that incorporates these singularities. What does this mean in the most general sense and to us who are used to quantum mechanical world? It is clear that there exists a spatio temporal self determination of the problem in which (eb) the problem advances, making up for (e) its deficiencies and thwarting (e) its own conditionalities. This can be made possible only by a transcendental power or complete computer simulation ad dissimulation. Mention may be made that many studies of the Universe being a computer has been put forward. And it had its many ramifications in the positive direction, albeit it did not received the much needed accentuation and augmentation when the theory was proposed. There is a mistaken notion that once the solution is obtained, problem is solved. Infact solutions are engendered precisely at (eb) the same moment problem determines itself. Thus sense in its organsiation of problems and solutions, aleatory and (e&eb) singular points, series and displacements are (=) doubly generative. Solutions does not attribute a subjective status to the problem retrospectively as is thought of by the widest commonalty spread when the problem is determined it also determines the solutions under which it persist. Argument also can be put forth from Stoic Philosophy that in order for the thing to be bad, it should have been good. But it has its own limitations as one could discern with circumspection and jurisprudence. For instance, Deleuze criticizes Kant for copying the transcendental field in the image of (e) the empirical field. In fact Kant himself clarifies that the figment of imagination lies dormant like in the mind. If cinnabar were now red, now black, now light, now heavy, if a human being were now changed into this animal shape, now into that one, if on the longest day the land were covered now with fruits, now with ice and snow, then my empirical imagination would never even get the opportunity to think of (e) heavy cinnabar on the occasion of the representation of the color red; or if a certain word were now attributed now to this thing, now to that, or if one and the same thing were sometimes called this, sometimes that, without the governance of (e&eb) a certain rule to which the appearances are already subjected (e&eb) in themselves, then no empirical synthesis of reproduction could take place (CPR, A100-101) as quoted in Real Experience and Possible Experience: Deleuze's Ontology of Experience – Conclusion. This is very much true,. In fact associations are created because of the nonchangeabilityof of the object, notwithstanding certain change in the subject. Such continuous associations are what form the basis of our understanding or misunderstanding (see earlier papers). That is, empirical experience is (=) personal, identitarian and centripetal; there is (=) a central focus, the subject, in which all our experiences are tagged as belonging (e&eb) to us. Mention may be made that Satre established that pre reflexive cogito is primary consciousness notwithstanding the fact that he makes in later work, he makes this his original point of departure. Kant says this empirical identity is only possible if (e) we can posit the Transcendental Unity of Apperception, that is, the possibility of adding "I think" to (e&eb) all our judgments. Instead of this smuggled-in or "traced" identity, Deleuze will want to have the transcendental field be (=) differential. Deleuze still wants to work back from experience, but since the condition cannot (e) resemble the conditioned, and since the empirical is (=) personal and individuated, the transcendental must be (=) impersonal and pre-individual. Deleuze is of the opinion that the interrogative problem cannot bear resemblance to propositions it subsumes(e) under it; it rather engenders (eb) them as it determines its own conditions and assigns (eb) individual order of individual order of permutation of (e) the propositions within (eb) the framework of generalised signification (See seventeenth series of static genesis) The virtual is the condition for (e) real experience, but it has (e) no identity; identities of the subject and the object are products of (e) processes that resolve, integrate, or actualize (the three terms are synonymous for Deleuze) a differential field. Satre was furious about Descartes for having confused spontaneous doubt which is consciousness with methodological doubt. I may add the later might arise from the non emotional feeling, and the question of consciousness itself would remain slightly confused with Satre as far as the author is concerned. Satre holds that all consciousness is consciousness of something. In other words consciousness is (=) pre reflexive and directive. It is (=) certainly (consciousness) intentional or so it would seem. Author's view is that consciousness is not utterly translucent but is to major extent cultivated through reference groups and peer groups which follow the principle of making a choice of 'coming up in life". "I know" is a tendency that grows in an individual and this is a relation with his objects or information (as we have taken) in mind which is essentially anagrammatic. The Deleuzean virtual is (=) thus not the condition of possibility of (e) any rational experience, but the condition of (e) genesis of real experience. Interrogation itself is (=) the shadow of the problem projected, or rather reconstructed based on (e) empirical propositions. This is true of every parameter like language, region, religion, science. As we have seen, the virtual, as genetic ground of the actual cannot (e) resemble that which it grounds; thus, if we are confronted with actual identities in experience, then (eb) the virtual ground of those identities must be purely differential. Deleuze adopts "multiplicity" from Bergson as the name for such a purely differential field. In this usage, Deleuze later clarifies; "multiplicity" designates the multiple as (=) a substantive, rather than as (=) a predicate. Deleuze has been candid about the fact that there exists no parallelism between logical genesis and (e&eb) ontological genesis. There is rather a relay between logical genesis and ontological genesis which permits every sort of shifting (e&eb) and jamming. It is therefore too simple to argue for the correspondence between the individual and (e&eb) the denotation the person and (e&eb) manifestation, multiple properties or variable properties and (e&eb) signification. (Seventeenth series of logical genesis) The multiple as predicate generates (eb) a set of philosophical problems under (e&eb) the rubric of "the one and the many" (things is one or multiple, one and multiple, and so on). With multiplicity, or the multiple as substantive, the question of the relation between the predicates one/multiple is replaced by (e&eb) the question of distinguishing types of multiplicities (as with Bergson's distinction of qualitative and (er&eb) quantitative multiplicities in Time and Free Will). A typological difference between (e&eb)substantive multiplicities, in short, is substituted for (e&eb) the dialectical opposition of the one and the multiple. In sum, then, against the "major" post-Kantian tradition of Fichte, Schelling, and Hegel, Deleuze in effect posited his (el&eb) own "minor" post-Kantian trio of Maimon, Nietzsche, and Bergson. To these he added a trio of pre-Kantians, Spinoza, Leibniz and Hume, but read through a post-Kantian lens. We have already touched on Deleuze's reading of Hume. Let us now turn to Spinoza, for whom Deleuze's admiration was seemingly limitless; for Deleuze, Spinoza was the "prince" or even the "Christ" of philosophers. There are many Spinozist inheritances in Deleuze, but one of the most important is certainly the notion of univocity in ontology. Univocity—as opposed to its great rivals, equivocity and analogy—is (=) the key to developing (eb) a "philosophy of difference" (Deleuze's term for his project in Difference and Repetition), in which difference would no longer be (=) subordinated to identity. The result is a Spinozism minus (-MD) substance, (=) a purely modal or (=) differential universe. In univocity, as Deleuze reads Spinoza, the single sense of Being frees (e) a charge of difference throughout all that is. In univocal ontology being is said in a single sense of (e) all of which it is said, but it is said of difference itself. What is that difference? Difference is (=) difference in degrees of "power"; in interpreting this term we must distinguish the two French words puissance and pouvoir. In social terms, puissance is (=) immanent power, power to act (e&eb) rather than power to (e) dominate another; we could say that puissance is (=) praxis (in which equals clash or act together) rather than poiesis (in which others are matter to be formed by the command of a superior, a sense of transcendent power that matches (e&eb) what pouvoir indicates for Deleuze). In the most general terms Deleuze develops throughout his career, puissance is (=) the ability to affect and to be affected, to form (eb) assemblages or consistencies, that is, to form (eb) emergent unities that nonetheless respect the heterogeneity of their components. (Here we see the empiricist theme of the "externality of relations": in an assemblage or consistency, the "becoming" or relation of the terms attains (eb) its own independent ontological status. In Deleuze's favorite example, the wasp and orchid create (eb) a "becoming" or symbiotic emergent unit.). Although Deleuze wrote a touching and certainly important book in tribute to his friend Foucault after the latter's death in 1984, the final important figure in Deleuze's readings of other philosophers is Leibniz, to whom, it must be recalled, Maimon appealed in his criticism of Kant. In 1988, Deleuze published a book on Leibniz entitled The Fold: Leibniz and the Baroque, which added new elements to the reading of Leibniz that appeared in Deleuze's earlier books: an interpretation centered on the concept of the fold, a development of a concept of the Baroque, and a attempt to define a neo-Leibnizianism in terms of (e&eb) contemporary artistic and scientific practices. While The Fold is a fascinating work, we will concentrate here on Deleuze's early reading of Leibniz, which plays an important role in Difference and Repetition. Deleuze pushes Leibniz's thought to a point where Leibniz could never have taken it, given his (Leibniz's) theological presuppositions. This is the point where one begins to consider the virtual domain on its own account, freed from (e) its actualization in a world and its individuals. Never has the enterprise and industry of "demystification" been further to the horizon where a person stands on the threshold of infinity trying to ponder what lies beyond its viel which separates the seen from unseen. Myth is always the expression (e) false infinite and thé disturbance of spirit. One of the most profound constants of Naturalism is to denounce everything that is (=) sadness, everything that is (=) cause of sadness, and everything that needs (e) sadness to exercise its power. Naturalism makes of (e) thought and sensibility (=)an affirmation .Naturalism directs its attack against (e&eb) the prestige of the negative (negativity is not bad and it has its own cognizance and prestige) Naturalism deprives (e) negative of all its power. Naturalism also disallows (e) negativity to speak in the name of philosophy which is unfair. Afterall, the spirit of negative made an appearance out of (e) the sensible and linked (e&eb) the intelligible to (e&eb) One or the Whole. But this one and One Whole as we have stressed many a time is that which cancels each projections, actions, cognitions, perceptions, concurrences, rotations, foldings, motions and shocks in the universe atleast holistically and is conservative. This bears ample testimony and infallible observatory and impeccable demonstration to the fact that One and the Whole is (=) nothingness of thought. On a similar veing appearance might also be (=) nothing ness of sensation. Naturalism is (=) the thought of an infinite sum all of the elements which are not composed at once. Naturalism is (=) also the sensation of finite compounds which are not (e) added up as such with one another. Thus multiplicity is (=) affirmed Multiple of multiple is (=) the object of affirmation .Diverse of diverse is (=) an object of joy. Notwithstanding the fact that gender is no longer widely considered to be a property of individuals, the alternative of viewing it in terms of (e&eb) performativity, where gender is (=) the outcome of linguistic and social performances, unnecessarily limits (e) the possibilities of thinking of gender as(=) a form of multiplicity that is both internally and externally differentiated. Any attempt to move beyond binary thinking in gender relations initiates (eb) a consideration of multiplicity, and the way in which multiplicity is conceptualized exerts a critical influence on (e&eb) the possibilities that are opened up. This article interrogates existing understandings of multiplicity and finds (eb) three actual or possible types - multiplicities of the same, characteristic of feminist approaches which authors critique through (e&eb) a reconceptualization of desire; multiplicities of (e) the third, characterized by anthropological, transgender and queer theory approaches; and multiplicities of difference and dispersion, typified by the rhizomatics and fluid theorizing of Deleuze and Guattari, Grosz and Olkowski. They propose ontology of gender as (=) a creative and productive form of desire, realized as (=) proliferation in Deleuze and Guattari's model of the rhizome. Gender identity is accordingly rethought as (=) immanence, intensity and consistency. **Gender as multiplicity: Desire, displacement, difference and dispersion Stephen Linstead Alison Pullen.** On this score, Deleuze often likes to cite Jorge Luis Borges's famous story, "The Garden of the Forking Paths," in which such a virtual world is described in (eb) the labyrinthine book of a Chinese philosopher named Ts'ui Pên: "In all fiction, when a man is faced with (e&eb) alternatives, he chooses one at the expense of (e) others. In the almost unfathomable Ts'ui Pên, he chooses—simultaneously—all of (e) them… In Ts'ui Pên's work, all the possible solutions occur, each one being the point of departure for (e) other bifurcations." Leibniz had in fact given a similar presentation of the world at the conclusion of the Theodicy. In Deleuze's transformation of the Leibnizian / Borgesian image, the three Kantian transcendent Ideas of God, World, and Self all take on (eb) a completely different demeanor. . First, God is no longer a Being who compares and chooses (e&eb) the richest compossible world; he has now become (eb) a pure Process that affirms incompossibilities and passes through (e&eb) them. (As the notion of "process" here attests, Deleuze's relation to Whitehead is one of the most important contemporary issues for students of his thought; although the points of comparison are many, Deleuze himself rarely discussed Whitehead, save for several important pages in The Fold.) Second, the world is no longer a continuous world defined by (e) its pre-established harmony; instead, divergences, bifurcations, and incompossibles must now be seen to belong to (e) one and the same universe, a chaotic universe in which divergent series trace (e&eb) endlessly bifurcating paths, and give rise to (eb) violent discords and dissonances that are never resolved into (eb) a harmonic tonality: a "chaosmos," as Deleuze puts it (borrowing a word from Joyce) and no longer a world. In contrast, Leibniz could only save the "harmony" of this world by relegating (e) discordances and disharmonies to other possible worlds—this was his theological sleight of hand. Compare this with the present parallel universe philosophy which has intearctionability as its main thematic and discursive form. Third, selves or individuals, rather than being closed upon the compossible and convergent world they express from within, are now torn open, and kept open through (e&eb)the divergent series and incompossible ensembles that continually pull them outside themselves. The "monadic" subject, as Deleuze puts it, becomes (=) the "nomadic" subject. Pluralism is always linked to (e&eb) multiple affirmation. The interrogation problem does not bear resemblance to (e) the proposition it subsumes under it; it rather engenders them as it determines (eb) its own conditions and assigns (eb) individual order of permutation of the propositions within (eb) the framework of generalised significations and functionalized manifestations. Sensuality is connected with (e&eb) the joy of the diverse (one gentleman here says variety is the spice of life; so diversity is spice and savoury to be palatable). In other words, if Deleuze is Leibnizian, it is only by eliminating the idea of a God who chooses (e&eb)

the best of all possible worlds, with (e&eb) its pre-established harmony and well-established selves; in Deleuze, incompossibilities and dissonances belong to (eb) one and the same world, the only world, our world. But they belong to our world as (=) its virtual register; developing the thought of the virtual is one of the great challenges of Deleuze's masterpiece, Difference and Repetition, to which we now turn. **The Philosophy of Difference Difference and Repetition:** Deleuze's historical monographs were, in a sense, preliminary sketches for the great canvas of Difference and Repetition (1968), which marshaled these resources from the history of philosophy in an ambitious project to construct a "philosophy of difference." Following Maimon's critique, Difference and Repetition produces a two-fold shift from the Kantian project of providing (eb) the universal and necessary conditions for (e) possible experience. First, rather than seeking the conditions for possible experience, Deleuze wants to provide an account of the genesis of (e) real experience, that is (=) the experience of this concretely existing individual here and now. Second, the genetic principle to respect the demands of the philosophy of difference must itself be (=) a differential principle. However, despite these departures, Deleuze maintains a crucial alignment with Kant; Difference and Repetition is (=) still a transcendental approach. Here we should remind ourselves that the terms "transcendent" and "transcendental" have (e) opposing significations. Transcendental philosophy in fact critiques (eb) the pretensions of other philosophies to transcend (e) experience by providing (eb) strict criteria for the use of (e) syntheses immanent to experience. On this score, at least, Deleuze aligns himself with Kant's critical philosophy. Three further preliminary notes are in order here. First, as we will discuss in section 4 below, the Capitalism and Schizophrenia project of Deleuze and Guattari will bring to the fore naturalist tendencies that are only implicitly present in the still-Kantian framework of Difference and Repetition. So, although there is some risk of reading backwards in this formulation, we can say that the "of" in the phrase "the experience of (e) this concretely existing individual here and now" is (=) both subjective and objective. It is the experience by (e) human subjects of this individual object in front of it, and it is (=) the experience enjoyed by (e) the concretely existing individual itself, even when that individual is (=) non-human or even non-living. (Deleuze's panpsychism is treated briefly in Protevi 2011.) Many Physicists' have taken objection to any "quantum information" being expended after life, for Einstein's Field Equations does not characterise such a situation, notwithstanding the fact that the equations provide travel backwards in time and the referential integrity and concomitant relational veracity of the equations are unquestionably true. (Please see earlier papers) It is very consistent to bring in to the incorporation the expositional quality Deleuzian remarks about the quantitative and qualitative aspects of life as is studied in LOS (page 310): Then suddenly there is a click. The subject breaks away (e) from the object divesting (e&eb) it of a part of its colour and substance. There is (=) a rift in the scheme of things and the whole range of objects crumbles in becoming (eb) me; each object transferring (e&eb)its quality to an appropriate subject. The light becomes (=) the eye, and such no longer exists; it is (=) simply the stimulation of the retina. Te smell becomes (eb) the nostril- and the world declares itself (eb) odorless. The song of the wind in the trees is (=) disavowed: it was (=) nothing but the quivering of the timpani……………………The subject is (=) the disqualified object. My eye is (=) the corpse of the light and color. My nose is (=) all that remains of odors when their unreality becomes manifested and demonstrated. My hand refutes (e) the thing it holds. Thus the problem of awareness is born of (e) anachronism. It implies (eb) the simultaneous existence of the subject and the object whose mysterious relationship to (E&eb) himself he seeks to define. Subject and object cannot (e) exist apart from one another since they are one and the same at first integrated (e&eb) in to the real world and then cast out by (e) it. (I have written from small note made by me years ago; there might be some variations. Kindly pardon me on that count. Essence however remains the same). Second, then, in the demand for genetic principles to account for the real experience of (e) concrete individuals, Deleuze is working in the tradition of the Principle of Sufficient Reason. Third, the notion of "genesis" is (=) itself double; in Chapter 3, Deleuze lays out a dynamic genesis that moves from an encounter with intensity in sensation to (e&eb) the thinking of virtual Ideas, while Chapters 4 and 5 lay out a static genesis that moves from the virtual Idea through (e&eb) an intensive individuation process to (e&eb) an actual entity. We are now ready to discuss the book itself. Murphy 1992 suggests that the first part of the book (the Introduction and Chapters 1 and 2) constitutes Deleuze's treatment of the history of philosophy, while in the second part of the book (Chapters 4 and 5) Deleuze is doing philosophy in his own name. From this point of view, Chapter 3, on the "image of thought," plays a pivotal role, leading us into

Deleuze's own philosophy. This transitional role of Chapter 3 is confirmed elsewhere when Deleuze says that the study of the image of thought is (=) the “prolegomena to philosophy” (Negotiations, 149). In Chapters 1 and 2, to find a differential genetic principle, Deleuze works through the history of philosophy to isolate the concepts of “difference in itself” and (e&eb) “repetition for itself” that the assumptions of previous philosophies had prevented from (e) being formulated. “Difference in itself” is (=) difference that is freed from (e) identities seen as metaphysically primary. Normally, difference is conceived of as (=) an empirical relation between two terms which each has (e) a prior identity of its own (“x is different from y”). Deleuze inverts this priority: identity persists, but identity is now a something produced by (e) a prior relation between (e&eb) differentials (dx rather than not-x). Difference is no longer an empirical relation but becomes (=) a transcendental principle that constitutes (e&eb) the sufficient reason of (e) empirical diversity (for example, it is the difference of electrical potential between cloud and ground that constitutes (eb) the sufficient reason of the phenomenon of lightning). In Chapter 2, the concept of “repetition for itself” is produced as (=) repetition that is freed from (e) being repetition of an original self-identical thing so that it can be (=) the repetition of difference. Following the formula of Deleuze's reading of Nietzsche's eternal return, repetition is (=) the return of the differential genetic condition of (e) real experience each time there is (=) an individuation of a concrete entity. Ultimately, then, Difference and Repetition will show (eb) that the individuation of entities is produced by (e) the actualization, integration, or resolution (the terms are synonymous for Deleuze) of a differentiated virtual field of (e) Ideas or “multiplicities” that are themselves changed, via (e&eb) “counter-effectuation,” in (eb) each individuating event. Chapter 3 lays out 8 postulates of the “dogmatic image of thought.” Between the first four and last four postulates we find a theory of the faculties, which is thus at the crossroads of both the chapter and the book. Let us take up the first four postulates. The first postulate concerns our supposed natural disposition to (e) think; the denial of this (natural disposition to think) is (=) what necessitates our being forced to think. The second and third postulates concern subjective and (e&eb) objective unity. Subjective unity is captured by (e) the notion of “common sense” such that our faculties of sensation, memory, imagination, and thought work in harmony, while objective unity is captured by (e) the notion of “recognition” such that it is the same object that is sensed, remembered, imagined, and thought. The fourth postulate concerns “representation”, a key target of Deleuze's critique. Here difference is submitted to a fourfold structure that renders (eb) difference subordinate to (e) identity: 1) identity in (eb) the concept; 2) opposition of (e) predicates; 3) analogy in (eb) judgment; and 4) resemblance in (eb) perception. A good way to approach Deleuze's notion of representation is via (e&eb) Aristotle and Porphyry. Specific differences are the opposed predicates that function on (eb) a horizon of identity in the concept under division; thus animal is the genus that is divided into rational and irrational as specific differences that enable (eb) the isolation of the species “human.” Then, we find that the difference between individuals of the same species is (=) infra-conceptual and can only be made via (e&eb) the perception of resemblances; Theaetetus looks like Socrates but not so much that they cannot be distinguished. Finally, the relation of substance to (e&eb) the other categories is (=) analogical, such that being is (=) said in many ways, but with substance as the primary way in (eb) which it is said. After the first four postulates, we find the theory of the faculties, which will be Deleuze's account of what it means to be (=) “forced” to think in differential rather than identitarian terms. To free a notion of “difference in itself” such that difference need not be thought on the basis of (e) a prior horizon of identity, Deleuze looks for an “encounter,” a sensation that cannot (e) be thought, that cannot find (eb) the empirical category under which an object can be recognized, and thus forces (eb) the “transcendent exercise” of the faculty of sensibility, when something can only be sensed. Here we see the dynamic genesis from intensity in sensation to (e&eb) the thinking of virtual Ideas. Each step here has (e) a distinct Kantian echo. The faculties are (=) linked in order; here Deleuze as well as Kant looks to the privilege of sensibility as (=) the origin of knowledge—the “truth of empiricism.” With sensibility, pure difference in intensity is grasped immediately in the encounter as (=) thé sentiendum, that which can only be sensed. In the differential theory of the faculties, sensibility, imagination, memory, and thought all “communicate violence” from one to (e&eb) the other—here Deleuze works with the Kantian notion of the sublime as (=) discordant accord of the faculties. The “free form of difference” in intensity moves each faculty and communicates its violence to (e&eb) the next, though in this case there is no supernatural vocation that will redeem (e&eb) the conflict of imagination and reason, as there is in the resolution (e) to the discussion of the sublime in the Critique of Judgment. Rather than a reconciliation of the faculties, with (e&eb) thought, a "fractured self"—here Deleuze takes up Kant's notion of the split (e&eb) between the empirical ego and the transcendental subject—is constrained (e) to think "difference in itself" in Ideas. For now, let us note that two of Deleuze's technical terms, intensity and (e&eb) virtuality, occupy two different places on (eb) this line of dynamic genesis. Intensity is (=) the characteristic of the encounter, and sets off (eb) the process of thinking, while virtuality is (=) the characteristic of the Idea. Extensive differences, such as length, area or volume, are (=) intrinsically divisible. A volume of matter divided into two equal halves produces (eb) two volumes, each having half the extent of the original one. Intensive differences, by contrast, refer to (e) properties such as temperature or pressure that cannot (e) be so divided. Recently scientists have been able to separate the characterstics from the object and this has been a thoroughbred break in quantum mechanics. In this connection, advert to the definition of "error' by Deleuze which we discuss elsewhere in the following. If a volume of water whose temperature is 90º is divided in half, the result is (=) two volumes at the original temperature, not two volumes at 45º. However, the important property of intensity is not that it is (=) indivisible, but that it is (=) a property that cannot (e) be divided without (e) involving a change in kind. The temperature of a volume of water, for instance, can be "divided" by (e) heating the container from below, causing (eb) a temperature difference between the top and the bottom. In so doing, however, we change (e&eb) the system qualitatively; moreover, if the temperature differences reach a certain threshold (if they attain a certain "intensity" in Deleuze's terms), the system will undergo (e&eb) a "phase transition," losing (e) symmetry and changing (e&eb) its dynamics, entering into (eb) a periodic pattern of motion—convection—which displays (eb) extensive properties of size: X centimeters of length and breadth. Drawing on these kinds of analyses, Deleuze will assign (eb) a **transcendental status** to the intensive**: intensity,** he argues, constitutes (e) the genetic condition of (e) extensive space. Intensive processes are themselves in turn structured by (e&eb) Ideas or multiplicities. An Idea or multiplicity is (=) really a process of progressive determination of differential elements, differential relations, and singularities. Let us take these step-by-step. "Elements" must have no independent existence from (e) the system in which they inhere; phonemes as the elements of the virtual linguistic Idea are (=) an example Deleuze uses in Difference and Repetition. Here it might be said the conjecture is too disconcerting for Deleuze seems to contradict himself from the propositions of logical genesis and ontological genesis as he had so assiduously alluded to before. When phonemes are actualized they enter into differential relations that determine (eb) the patterns of individual languages; thus the English phoneme /p/ is reciprocally determined by (e) its differences from /t/, /b/, /d/, and so on. Finally, these differential relations of an individual language determine (eb) singularities or remarkable points at which the pattern of that language can shift: the Great Vowel Shift of Middle English being an example, or more prosaically, dialect pronunciation shifts. Deleuze also holds that events have such points of inflexion, boiling points et al., For another example—and here, in the applicability of his schema to (e&eb) widely divergent registers, is one of the aspects of Deleuze as metaphysician—let us try to construct the Idea of hurricanes. The differential elements would be material "flows" driven by (e) intensive differences in temperature and pressure but undetermined in form (neither smooth nor turbulent, neither big nor small) and function (neither forming nor destroying of (e) weather events). A suggestion can be made to create indeterminate spaces and modules in respect of such variables like 0/0; infinity/ infinity…….It is not as if such existence of indeterminate constituents are not palatable. An example is that of violation of general relativity at remotest parts of the universe as in case of a bill in transit that remains unsecure in its obligation. These flows qua differential elements enter into relations of reciprocal determination linking changes in any one element to (e&eb) changes in the others; Thus temperature and pressure differences will link changes in air and (e&eb) water currents to each other. Updrafts are related to (e&eb) downdrafts even if the exact relations (the tightness of the links (e&eb) the velocity of the flows) are not yet determined. Finally, at singular points in these relations singularities are determined that mark (eb) qualitative shifts in the system, such as the formation of thunderstorm cells (e&eb) the eye wall, and so on. But this is still the virtual Idea of hurricanes; real existent hurricanes will have (e) measurable values of these variables so that we can move from (e) the philosophical realm of sufficient reason to that of scientific causation. A hurricane is explained by (e) it's Idea, but it is caused by (e) real wind currents driven by (e) real temperature supplied by (e) the sun to (e&eb) tropical waters.. To see how Ideas are transcendental and immanent, we have to appreciate that an Idea is (=) a concrete universal. There is a statement in Bhagavat Geeta that creation is attributed and ascribed to "Yoga maya" of Brahman itself. In fact as had been stated earlier both Brahman and Anti Brahman form two sides of the same coin what with Vishwaroopa of Vishnu standing out for both benediction and belligerence. Advert various papers on the indeterminate and latent thought and manifest action (cf Merton) in various papers on Holographic principle, where in it is clearly stated that the information at the boundary is what is being produced at the universe virtually like a film. Let us for the present state that it is the mind that projects this Universal Mind's thought on the screen of consciousness of individual which is mistaken for objective reality. By Universal Mind we mean cosmic consciousness or Nature's General ledger which has been proposed and defined many a time earlier in the deliberation on various topics like Holographic principle, Quantum Holography, and its concomitance to string theory. This aspect is further discussed and expatiated upon in further papers exclusively. In an early article on Bergson ("The Conception of Difference in Bergson" [1956]), Deleuze gave a particularly helpful example of this notion. In La Pensée ET le Mouvant, Bergson had shown that there are two ways of determining (eb) what the spectrum of "colors" has in (eb) common. (1) You can extract from (e) particular colors an abstract and general idea of color ("by removing from the red that which makes (eb) it red, from the blue what makes it blue, from the green what makes it (eb) green"). Or, (2) you can make all these colors "pass through (e&eb) a convergent lens, bringing them to a single point," in which case a "pure white light" is obtained that "makes the (eb) differences between the shades stand out." Please see earlier papers colours are befuddling you" The former case defines a single generic "concept" with (e&eb) a plurality of objects The relation between concept and (e&eb) object is (=) one of subsumption; and the state of difference remains exterior to (e) the thing. Here Deleuze makes a profound statement. It is virtual statement that concept itself is object and both cannot coexist like subject and object. Startling both in its thematic and discursive form genius of Deleuze finds its pristine glory in Eastern primordial thought. The second case (see item numbered 156) on the contrary, defines (eb) a differential Idea in (eb) the Deleuzean sense: the different colors are no longer objects under (e&eb) a concept, but constitute (e) an order of mixture in coexistence and succession within (eb) the Idea; the relation between the Idea and (e&eb) a given color is (=) not one of subsumption, but one of (e) actualization and differenciation (it si the actualisation and manifestation in space time of the idea that is what we spoke as hologram); and the state of difference between the concept and the object is (=) internalized in (eb) the Idea itself, so that the concept itself has become (=) the object. White light is still a universal, but it is (=) a concrete universal, and not a genus or generality. Verily, this is what is enunciated as holographic principle and "Yoga Maya" of the Brahman-Anti Brahman co creation. Problem in itself is (=) the reality of the genetic element, the complex theme which does not allow itself to be reduced to (eb) propositional thesis and basis. It is one and the same illusion which from the empirical point of view formulates (eb) the problems from (e) the propositions, which function as (=) answers and which from a philosophical point of view and a scientific point of view , defines (eb) the problem through (e&eb) the form of possibility of (e) the corresponding propositions. As long as we define the problem by its possibility of resolvability (eb) we tend to confuse (e&eb) sense with (e&eb) signification and we conceive (eb) condition in (eb) the image of the conditioned. Domains of resolvability are related to (e&eb) the process of self determination of the problem. The series of the problem with the (e&eb) conditions constitute (eb) something unconditioned, determining at once, the conditions of the problem perse, and the domains of resolvability and the solutions present in the (eb) domain. Problem bears no resemblance to the neither to the propositions it subsumes (e) under it, nor to the relation it engenders in the proposition. Problem is (=) not propositional; although it does not exist outside of (e) the propositions which express it. Husserl cannot be followed blindly by the statement that an expression is (=) mere double and necessarily has the same thesis as that which receives it. The Idea of color is (=) thus like white light, which "perplexes" within (e&eb) itself the genetic elements and relations of all the colors, but which is (=) actualized in the diverse colors and their respective spaces. Like the word "problem," Deleuze uses the word "perplexion" to signify (eb) not a coefficient of doubt, hesitation, or astonishment, but (eb) the multiple and virtual state of Ideas. Indeed, Deleuze adopts a number of Neoplatonic notions to indicate (eb) the structure of Ideas, all of which are derived from (e) the root word pli [fold]: perplication, complication, implication, explication, and replication. Interrogation is (=) the shadow of the problem projected, or rater reconstructed based on (e) empirical propositions. Similarly, the Idea of sound could be conceived of as (=) a white noise, just as there is (=) also a white society or a white language, which contains (e) in its virtuality all the phonemes and relations destined to be actualized in (eb) the diverse languages and in (eb) the remarkable parts of a same language. Only a genius with profound thought beyond his space and time and period could have written what is written. Words are more often used to violate the very meaning of sentences which they try to exemplify and presumptuousness forms the bastion and stylobate of many philosophers. Deleuze being a contemporary thinker stands above all in his own right. Constantin Boundas refers to this century as "Deleuzean Century;" which is neither garish nor ostentatious. Attention drawn to remarks on the Difference which is really poised for natural history of philosophy **Deleuze's Readings of Other Philosophers** **I have added my comments and commentaries of other researchers including that of Deleuze. Where ever the comments are drawn from other sources, attributions are mentioned.** The yogi rises to the level of contemplation when the awareness he has of himself and the things around him become (=) one and he realises his own identity with (e&eb) Siva, the sole reality. This is a clear cut statement of Aham Brahmasmi, which is achieved by continuous evolution of consciousness. It is here individual consciousness become cosmic consciousness. The aim of this Yoga in all its phases is to achieve (e&eb) the Fourth State of consciousness (turiya) beyond the three states of waking, dreaming and deep sleep and to then ultimately reach the liberated state Beyond the Fourth (turiyatita). These five states correspond to: (a) Siva's activity (vyapara), that is, His power of action; (b) Siva's Lordship (adhipatya), which is His power of knowledge; (c) the absence of these two, which corresponds to Siva's power of will; (d) His exertion (prerakatva), which contains (e) all the cycles of creation and destruction and, (e) the rest Siva enjoys in His own nature, which is His power of consciousness. 296 The first three states, when divorced from the last two, belong to (e&eb) the sphere of transmigratory existence. The Fourth and Beyond the Fourth on the other hand are (=) higher, supramundane (alaukika) states of consciousness in which (eb) the yogi enjoys bliss and repose (**visranti**) in his own nature by penetrating (samavesa) into (e&eb)_ the universal consciousness of the Self, through (e&eb) which he ultimately becomes (eb) liberated (jivanmukta). We had earlier defined **"Self'** as witness consciousness and or dynamic consciousness in the evolved or evolutionary soul. Indriyateeta anubhava is what beyond sense organs experience. Note that the author does not classify the consciousness states and mentions only cosmic consciousness the Nature's General Ledger. Beyond the Fourth is (=) the state of awareness ParamaSiva Himself enjoys when (e) duality has entirely disappeared and everything is realised to be one with (e&eb) consciousness. It is clear that the author is talking about cosmic consciousness. The Fourth is the state of awareness of the yogi who, catching hold of the pure subjectivity (upalabdhrta) flowing through (e&eb) the lower three states, is still actively eliminating (e) his sense of duality. While the former is (=) the supreme subject as T consciousness (aham), the latter is (=) the pure awareness (prama) or 4 I-nesses (ahanta) of (e) the subject which encompasses the lower states, giving them (eb) life and uniting them (e&eb) together. 297 As such, the Fourth State is (=) the reflective awareness of one's own nature shining in (eb) all three states at one with them. 298 The fact that we recall that we slept well is proof (eb) that this state of consciousness persists even in deep sleep. Indeed, if the flow of Turiya could somehow be (=) brought to a halt, all the other states of consciousness would come to an end in (eb) the absence of the pure subjectivity which makes them, and their contents, manifest. 299 The states of waking, dreaming and deep sleep correspond to (e&eb) the form of awareness consciousness assumes when (e) it predominantly manifest as (=) the object, means of knowledge and individual subject, respectively. Turiya is the pure awareness (prama) that both transcends (e) them and merges them all into (e&eb) itself. 300 As such, it appears as the triad of deed, means and agent in the pure act (vyapara) of (e) consciousness unsullied by (e) any outer reality. 301 Abhinava explains: {Turiya) transcends (e) the three aspects of *form\ 'sight' and T consisting as it does of (e) the pure act of 'seeing'; therefore any means [by which this state could be realised] has (e) merely a [provisional] instrumental value. It is, in other words, pure subjectivity of (e) the nature of absolute freedom, independent of (e) all external means. This is the state of consciousness called Turiya, luminous with (e&eb) its own light. Turiya is thus **not just a psychological state** but the supreme creative power (para sakti) of (e) consciousness, the Goddess (samviddevi) who generates and withdraws the (e&eb) entire universe of subject, object and means of knowledge. In the Heart of Recognition Ksemaraja explains: Whenever the extroverted [conscious] nature rests within (eb) itself, external objectivity is (=) withdrawn and consciousness is established in (eb) the inner abode of peace which threads through (e&eb) the flux of awareness in (eb) every [externally] emanated [state]. Thus **Turiya**, the Goddess of Consciousness, is the union of creation (e&eb) persistence and (e&eb) destruction. She emanates (eb) every individual [cycle] of (e) creation and withdraws (e) it. Eternally full [of (e) all things] and [yet] void [of (e) diversity] She is (=) both and yet neither, shining radiantly as (=) **non-successive** [consciousness] alone. 303 The yogi is fully absorbed in this state of consciousness and takes possession of (e) its power when he is able to rise from (e) contemplation (samadhi) carrying with (e&eb) him the abiding awareness of Turiya throughout (e&eb) his waking, dreaming and deep sleep. When he achieves this constantly, he continues to (e) experience these states individually, but they no longer obscure (e) the insight (pratibha) he has acquired because (e) he realises that they are all aspects of the bliss of Turiya. Thus, while the common man calls this state the 'Fourth' (turiya) because (e) he cannot experience it directly and knows only that it is beyond the other three, the yogi calls it 'Beyond (e) Form' **(rupatita)** because it transcends (e) the detachment of the state of deep sleep which, devoid of (e) objective content, is (=) the naked form' of the individual subject tending towards (e&eb) the fullness of consciousness. Those who are on the path of knowledge (jnaniri) call it the 'Whole* **(pracaya)** because (e) in this state, they see the entire universe gathered together in (e&eb) one place. 304 This is something like Nature's General Ledger 'Supra-mental Awareness' (**manonmana**) is (=) the name given to the experience of Turiya in (eb) the waking state. The yogi in this state moves and lives (e&eb) in the world of waking experience free of (e) all disturbing thoughts while abiding in (eb) the transcendental silence beyond (e) the activities of the mind. 'Infinite' is the name of the experience of Turiya while dreaming because (e) free of the limitations imposed upon (e&eb) the body by time and space, the yogi enjoys (e&eb) the unlimited expanse of the Self. Mention here is the attachment of the self with infinite expanse of nature beyond space and time.When Turiya is experienced in deep sleep, the yogi's state is called 'All things' (sarvdrtha) because in it he discovers his freedom from limitations in this, the most contracted state of human consciousness. The yogi who manages to maintain Turiya- consciousness comes to (e) experience the three states of waking, dreaming and deep sleep as the constant flow of the bliss of consciousness in which all traces of the relative distinction between these states and their contents is eradicated. 305 Following the stream of Turiya to its highest level (para katfha), he reaches the state Beyond the Fourth (turiydtita), which is the universal consciousness (caitanya) of the Self. Here the yogi comes to rest within his own nature. Plunged in the vast, waveless ocean of the consciousness and bliss (ciddnanda) of the state Beyond the Fourth, the yogi becomes Siva, 306 the Free One (svacchanda), and thus wanders freely, practising the Yoga of Freedom. 307 K§emaraja equates the Fourth State with the pure (suddha), innate (sahaja) knowledge that one's own conscious nature is all things. It is the Supra-mental State (unmana) in which Siva's pervasive presence is experienced 308 once the Yoga practised at the Individual level attains fruition at the Empowered. 309 What the yogi must do, once consciousness is elevated to grasp the Fourth State, is make it constant. He must forcefully lay hold of it within himself and not release his grip until it becomes permanent. Then he travels 'Beyond the Fourth' to enlighten- ment. 310 Before this ultimate attainment the yogi inevitably falls. The forces operating within consciousness that limit and obscure it throw him down whenever they possibly can. The only way the yogi can defend himself against them is to maintain a constant attentive awareness of the Fourth State. 311 He falls when (e) he is distracted but when he attends carefully to his pure conscious nature, he realises that every aspect of his state of being, including (e) the forces that lead him astray, are one with (e&eb) the pulsing flux of his own consciousness and so cannot affect him. These powers, which are the energies of Matrka we have already discussed, are not the only obstacles the yogi must overcome. He must, for example, also resist the temptation to rest content with the miraculous yogic powers (siddhi) he acquires in the course of his spiritual develop- ment. Again to do this he must practice Yoga. Similarly, in order to pervade the Fourth State gradually through the other states in the manner proper to practice at the Individual level, the method is the same. He must practise the higher yoga of the Tantras which, turning his mind inwards and freeing it from discursive representations, allows him to penetrate into the Supreme Principle. 312 Once the yogi has attained this contemplative state, his main problem is to make it permanent. In the introverted state the gross external movement of the breath is suspended and with it the activity of the intellect, mind, individualised consciousness, powers of the senses and the ego. 313 When the yogi rises out of this state, he is liable to fall again into the lower order of creation generated by Maya if he does not maintain his awareness of the higher reality he has experienced and allows his awakened, illumined insight to be obscured by the dream-like vision of thought-constructs. 314 Naturally, the yogi must rise out of the introverted condition of suspension. It is inherent in the very nature of reality that it should move out of itself. 315 Pure, universal consciousness initially transforms itself into the vital breath 316 charged with the impression iyasana) of the power of awareness attained through introversion. By attending to the pulse (spanda) of the breath as it moves out of the absolute, the yogi can develop an intuitive sense of the inherent unity of all he will perceive in the mental and physical spheres created by the outpouring of consciousness. In this way he realises that his own nature is everywhere present in all he perceives and that all things thus reside within him. Blessed with this insight his consciousness remains free and unlimited even at the individual level where the breath, mind, senses and body are active. If the yogi fails to do this, he finds himself once again beset by the strictures of his embodied existence and must, as before, try to pervade all his other states of consciousness with the aesthetic delight (rasa) and wonder (camatkara) of the Fourth State he experienced in contemplation. Again this means that he must strengthen his pure, empowered awareness that his universal nature manifests as all things. 317 In this way he discovers Siva's presence in every sphere of individualised consciousness ranging from the breath to outer objectivity. The yogi's mind then becomes tranquil and undistracted because wherever it may wander, the yogi perceives only Siva, his authentic nature. 318 Consciousness is thus freed of all external referents and the yogi's subjectivity is purified of all identification with the body or anything else that belongs to the objective sphere. The yogi then becomes detached from the opposites of pleasure and pain and is transcendentally free (kevalin). 319 yogis are again, however, liable to fall if he allows himself to get entangled in the play of opposites. This fall is more serious than the others because, although he is caught by the confining restrictions of individual- ised consciousness as before, he is now also affected by karma. Fleeing from pain in the pursuit of pleasure he is bound to act (karma) to minimise one and maximise the other and so is thrown down to the lowest level of embodied subjectivity (sakala). In order to regain his lost state, he must ascend gradually, by Siva's grace, from one order of subjectivity to the next and so free himself progressively of the limitations of the lower levels to gain the greater freedom and expansion of the higher. As he progresses, the objective sphere also evolves from the grossest perceptions of physical objects outside the lowest order to subjectivity, through to the subtler inner, mental perceptions to finally reach the order of subjectivity that contains objectivity within itself and is free to externalise it at will. 320 The degree to which this process develops depends, as before, on the yogi's awareness of the Fourth State. In consonance with the general principle that the remedy should suit the defect, the yogi is instructed to seek this higher state of consciousness in the wonder (camatkara) or delight (ananda) he feels in moments of intense physical pleasure. At first he experiences this subtle consciousness for an instant in the subjective sphere. If he manages to catch hold of it, it becomes more intense as the cognitive and objective spheres are also gradually pervaded and vitalised by it. Occasions for this practice are, for example, the sense of satisfaction one feels after a good meal or the aesthetic delight one experiences when listening to good music or the pleasure of sexual union with the Tantric consort or even solitary sexual excitation. In these moments of delight the yogi can penetrate momentarily into his own authentic Siva-nature (sambhavavesa) through the empowered contact (saktasparsa) m he makes with it in the freedom of the pure subjectivity of the Fourth State. 322 If the yogi develops his awareness of this higher level of consciousness and maintains it, he eventually experiences it constantly. 323 Clearly, what prevents the yogi from attending to his state of consciousness rather than the circumstances which induce it is the craving for pleasure (abhila§a) born of ignorance — the source of every impurity which clouds consciousness. Craving directs the yogi's attention towards outer, worldly things and so he is caught in the net of thought- constructs. 324 To free himself of his worldly desires and reverse this binding extroversion, the yogi must eradicate its cause. To be freed of all the ups and downs of the path and no longer be tormented by the possibility of a fall, the yogi must see reality perfectly and completely. This insight is itself liberation and the moment it dawns the yogi is instantly freed. This sudden realisation is the goal of Tantric Yoga. E Tantra declares: "He who perceives reality directly, even for the brief moment it takes to blink, is liberated that very instant and never reborn again." 325 Although the yogi's body and mind continue to function as before, they are like mere outer coverings 326 which contain, but do not obscure, the mighty, universal consciousness which operates through them. The yogi's body is (=) the universe, the senses (=) the energies that (eb, eb+)vitalise it, his mind (=) Mantra, the rhythm of his breath (eb) the pulse of time and his inner nature pure, dynamic consciousness. Raised above all practice, and hence all possibility of falling to lower levels, the yogi realises that he has always been free 327 and that his journey through (e&eb) the **dark land of Maya was nothing but a dream, a construct of his own imagination** **Contemplation (Samadhi) (Doctrine Of Vibration: S.G.Dyczkowski)(For models see Entanglement entropy et al)**

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In excited reveries: March 1, 11.45AM……….

For Nietzsche There Are (=) No Facts, Only (e&eb) Interpretations, And He Argues That All Interpretation Is Constituted By(e) The Individual's Perspectives And Is Thus Inevitably Laden With (e&eb) Presuppositions, Biases, And Limitations

That means facts are not realities!

There are no realities!

Then?

Only augmented or dissipated realities!

That is why accentuation and Attrion and Detrition coefficients are used!

Utch! What I mean is………

What?

Is fact collapse of wave function!

How?

You are seeing a fact, writing fact after seeing, reading a fact and so on……………………..

Interpretation?

That is where Wigner's paradox comes in!

What is reality I say?

Relativistic realities and no absolute truths!

I do not want philosophy!

It is the truth!

Fact is what you saw and you interpret that your friend and you need series of photographs from which you started!

It is like a film!

Hero sings a powerful melodious song and dies and slowly gets up and stars singing duet with the heroine!

You mean all interpretations are nonlinear while the expression is linear!

Yes!

Why are you attuned to arrow of time?

You are! I am not!

“You” is individual General ledger!

“I” is cosmic general ledger!

Former is contained in the later!

That does not matter or makes any difference to facts and interpretations’!

It does affect interpretations”!

That is relativistic truths!

Some fools like you donot understand basic facts about life!

Why so?

I donot know!

That is why you are a pariah!

Go spiritual!

Spirit is energy!

So?

Mental condition and physical condition must be compatible for such unison!

Simulation isnonlinear!

That is exactly madness!

Why?

Madness is to go at helter skel;ter speed from one to another !

It is a freerun!

What do you think your mind does!

From times other than examinations, it is nonlinear!

Externally imposed activity is necessary to keep it linear!

Yes!

That means there is madness in everyone!

Of course!

Hope you donot include protyons, quarks, neutrons in that category!

Why not! I think they must have their consciousness developed!

Expansion of individual consciousness makes you to bear nonlinearluty and does not affect your thinking linearly!

But who says linear thinking is the best to achieve results!

MIT finalists!

That is where indeterminism and uncertainty comes in!

Nature Materials | Article Proximate Kitaev quantum spin liquid behavior in a honeycomb magnet A. Banerjee, C. A. Bridges, et al Nature Materials (2016) doi: 10.1038/nmat4604

Quantum spin liquids (QSLs) are topological states of matter exhibiting remarkable properties such as the capacity to protect quantum information from decoherence. Whereas their featureless ground states have precluded their straightforward experimental identification, excited states are more revealing and particularly interesting owing to the emergence of fundamentally new excitations such as Majorana fermions. Ideal probes of these excitations are inelastic neutron scattering experiments. These we report here for a ruthenium-based material, α-RuCl3, continuing a major search (so far concentrated on iridium materials) for realizations of the celebrated Kitaev honeycomb topological QSL. Our measurements confirm the requisite strong spin–orbit coupling and low-temperature magnetic order matching predictions proximate to the QSL. We find stacking faults, inherent to the highly two-dimensional nature of the material, resolve an outstanding puzzle. Crucially, dynamical response measurements above interlayer energy scales are naturally accounted for in terms of deconfinement physics expected for QSLs. Comparing these with recent dynamical calculations involving gauge flux excitations and Majorana fermions of the pure Kitaev model, we propose the excitation spectrum of α-RuCl3 as a prime candidate for fractionalized Kitaev physics.

Schrödinger Approach to Mean Field Games Igor Swiecicki, Thierry Gobron, and Denis Ullmo Phys. Rev. Lett. 116, 128701 – Published 23 March 2016

Mean field games (MFG) provide a theoretical frame to model socioeconomic systems. In this Letter, we study a particular class of MFG that shows strong analogies with the nonlinear Schrödinger and Gross-Pitaevskii equations introduced in physics to describe a variety of physical phenomena. Using this bridge, many results and techniques developed along the years in the latter context can be transferred to the former, which provides both a new domain of application for the nonlinear Schrödinger equation and a new and fruitful approach in the study of mean field games. Utilizing this approach, we analyze in detail a population dynamics model in which the “players” are under a strong incentive to coordinate themselves.

Quantum physics has just been found hiding in one of the most important mathematical models of all time Mind = blown. BRENDAN COLE 4 APR 2016 Face book Icon

Game theory is a branch of mathematics that looks at how groups solve complex problems. The Schrödinger equation is the foundational equation of quantum mechanics - the area of physics focused on the smallest particles in the Universe. There's no reason to expect one to have anything to do with the other.

But according to a team of French physicists, it's possible to translate a huge number of problems in game theory into the language of quantum mechanics. In a new paper, they show that electrons and fish follow the exact same mathematics.

Schrödinger is famous in popular culture for his weird cat, but he's famous to physicists for being the first to write down an equation that fully describes the weird things that happen when you try to do experiments on the fundamental constituents of matter. He realised that you can't describe electrons or atoms or any of the other smallest pieces of the Universe as billiard balls that will be exactly where you expect them to be exactly when you expect them to be there.

Instead, you have to assume that particles have positions that are spread out in space, and that they only have some probability of appearing where you think they're going to be at any point in time. If you work with spread-out probabilities instead of with specific positions, you can exactly predict the results of a bunch of experiments that puzzled physicists at the beginning of the 20th century.

Schrödinger's equation tells you the relationship between how these probabilities change in time and the way they change in space. Working with probabilities instead of positions might be weird, but it works. And physicists aren't going to argue with success.

Game theory doesn't seem to have anything to do with any of that. In general, it looks at how a bunch of agents make decisions to get closer to whatever goal they have in mind. That could mean people (hopefully) working together in traffic, or it could be people working against each other like they do in a board game.

In mean-field game theory, the branch that this study looks at, you're analysing what all of the different agents are doing on average - so it might readily apply to people in traffic, but it'd be a lot harder to apply to a single game of Monopoly.

The fish generally move as a single group, with a bunch of individuals moving around pretty randomly within it. Every once in a while, a fish might see a piece of food away from everyone else, and swim over on its own to grab it, before swimming back to its school for safety.

This means that the fish have some distribution; they're concentrated in the group and rarer as you get farther away from it. In other words, if you pick a particular spot in space, there's some probability that you chose somewhere with a fish and some probability you chose somewhere without a fish. As the school swims past your spot, the probability of finding a fish there goes up. After the school moves beyond that point, the probability goes down.

The probability of finding a fish could have evolved in any number of complicated ways with equations that had never before been written down. But it doesn't. The probability of finding a fish changes exactly like the probability of finding an electron does. The fish follow Schrödinger's equation, Swiecicki and his team report.

In the next few years, we might see game theory proceed in leaps and bounds as it takes advantage of this new connection. Physicists have been stretching and contorting Schrödinger's equation for almost a century, and they've gotten really good at using it to solve even the most complicated problems. But mean-field game theory has only been around for 10 years or so, meaning that there are plenty of wide-open questions peppering the landscape.

Now, a huge range of those open problems might be translatable into the framework of quantum mechanics. Given how much effort has gone into solving every conceivable quantum mechanics problem, there' a good chance those new problems will end up looking a lot like something physicists have seen before.

The paper has been published in Physical Review Letters.

The example physicists led by Igor Swiecicki from France's Laboratoire de Physique Théorique Orsay use is a school of fish that want to stay near each other while also looking independently for food.

DOI:http://dx.doi.org/10.1103/PhysRevLett.116.128701 © 2016 American Physical Society Playing Games with Schrödinger Published 23 March 2016 Models that treat economic and biological behavior in terms of game-play resemble quantum mechanics. Igor Swiecicki1,2, Thierry Gobron2, and Denis Ullmo1,*Vol. 116, Iss. 12 — 25 March 2016

The editors of the Physical Review journals have curated a collection of landmark papers on General Relativity to celebrate its centennial. These papers are currently free to read.

New state of matter detected in a two-dimensional material April 4, 2016

An international team of researchers have found evidence of a mysterious new state of matter, first predicted 40 years ago, in a real material. This state, known as a quantum spin liquid, causes electrons - thought to be indivisible building blocks of nature - to break into pieces.

he researchers, including physicists from the University of Cambridge, measured the first signatures of these fractional particles, known as Majorana fermions, in a two-dimensional material with a structure similar to graphene. Their experimental results successfully matched with one of the main theoretical models for a quantum spin liquid, known as a Kitaev model. The results are reported in the journal Nature Materials

Quantum spin liquids are mysterious states of matter which are thought to be hiding in certain magnetic materials, but had not been conclusively sighted in nature.

The observation of one of their most intriguing properties—electron splitting, or fractionalisation—in real materials is a breakthrough. The resulting Majorana fermions may be used as building blocks of quantum computers, which would be far faster than conventional computers and would be able to perform calculations that could not be done otherwise.

"This is a new quantum state of matter, which has been predicted but hasn't been seen before," said Dr Johannes Knolle of Cambridge's Cavendish Laboratory, one of the paper's co-authors.

In a typical magnetic material, the electrons each behave like tiny bar magnets. And when a material is cooled to a low enough temperature, the 'magnets' will order themselves, so that all the north magnetic poles point in the same direction, for example.
But in a material containing a spin liquid state, even if that material is cooled to absolute zero, the bar magnets would not align but form an entangled soup caused by quantum fluctuations.

"Until recently, we didn't even know what the experimental fingerprints of a quantum spin liquid would look like," said paper co-author Dr Dmitry Kovrizhin, also from the Theory of Condensed Matter group of the Cavendish Laboratory. "One thing we've done in previous work is to ask, if I were performing experiments on a possible quantum spin liquid, what would I observe?"

Knolle and Kovrizhin's co-authors, led by the Oak Ridge National Laboratory, used neutron scattering techniques to look for experimental evidence of fractionalisation in crystals of ruthenium chloride (RuCl3). The researchers tested the magnetic properties of the RuCl3 crystals by illuminating them with neutrons, and observing the pattern of ripples that the neutrons produced on a screen.

A regular magnet would create distinct sharp spots, but it was a mystery what sort of pattern the Majorana fermions in a quantum spin liquid would make. The theoretical prediction of distinct signatures by Knolle and his collaborators in 2014 match well with what experimentalists observed on the screen, providing for the first time direct evidence of a quantum spin liquid and the fractionalisation of electrons in a two dimensional material.

"This is a new addition to a short list of known quantum states of matter," said Knolle.

"It's an important step for our understanding of quantum matter," said Kovrizhin. "It's fun to have another new quantum state that we've never seen before - it presents us with new possibilities to try new things."

Explore further: Quantum mapmakers complete first voyage through spin liquid

More information: Proximate Kitaev quantum spin liquid behaviour in a honeycomb magnet, Nature Materials, DOI: 10.1038/nmat4604

Read more at: http://phys.org/news/2016-04-state-two-dimensional-material.html#jCp

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Introduction:

Following abstracts are written in model able form and WE REFRAIN FROM GIVING MODEL FORMATS AND DOVETAILING EXPLANATIONS ATTRIBUTABLE TO SPATIAL RESTRICTIONS

Thermodynamics of black holes P C W Davies Reports on Progress in Physics, Volume 41, and Number

(1) Black holes appear to conform to (e) a very straightforward generalisation of standard laboratory thermodynamics.
(2) This generalised theory is examined in detail, and some concrete results are presented. The thermodynamic connection is based on (e) Hawking's application of quantum theory to (e) black holes, and the quantum aspects are described in detail from (e) several standpoints, both heuristic and otherwise.
(3) The precise mechanism by which the black hole produces thermal radiation, its nature and origin, and the energetics of back-reaction on the hole are reviewed.
(4) The thermal states of quantum holes are also treated using (e) the theory of thermal Green functions, and the entropy of the hole is shown to be related to (e&eb) the loss of information about the quantum states hidden (e) behind the event horizon.

(5) Some related topics such as accelerated mirrors and (e&eb) observers in Minkowski space, (e&eb) super-radiance from rotating holes and the thermodynamics of general self-gravitating systems are also briefly discussed. **Thermodynamics of black holes P C W Davies Reports on Progress in Physics, Volume 41, and Number**

On the extra mode and inconsistency of Hořava gravity D. Blasa, O. Pujolàsb and S. Sibiryakova,c Published 12 October 2009 • Journal of High Energy Physics, Volume 2009, JHEP10(2009)

(6) **D. Blasa, O. Pujolàsb and S. Sibiryakova, c** address the consistency of Hořava's proposal for a theory of quantum gravity from the low-energy perspective.
(7) They uncover the additional scalar degree of freedom arising from (e) the explicit breaking of the general covariance and study its properties.
(8) The analysis is performed both in (eb) the original formulation of the theory and in (eb) the Stückelberg picture.
(9) A peculiarity of the new mode is that it satisfies (eb) an equation of motion that is of (e) first order in time derivatives.
(10) At linear level the mode is manifest only around (e&eb) spatially inhomogeneous and time-dependent backgrounds.
(11) Authors find two serious problems associated with (e&eb) this mode. First, the mode develops (eb) very fast exponential instabilities at (eb) short distances.
(12) Second, it becomes (eb) strongly coupled at (eb) an extremely low cutoff scale.
(13) They also discuss the ``projectable'' version of (e) Hořava's proposal and argue that this version can be understood as (=) a certain limit of the ghost condensate model.
(14) The theory is still problematic since (e) the additional field generically forms (eb) caustics and, again, has a very low strong coupling scale.
(15) Authors clarify some subtleties that arise in (eb) the application of the Stückelberg formalism to Hořava's model due to its non-relativistic nature. **On the extra mode and inconsistency of Hořava gravity D. Blasa, O. Pujolàsb and S. Sibiryakova,c Published 12 October 2009 • Journal of High Energy Physics, Volume 2009, JHEP10(2009)**

Quantum gravity at a Lifshitz point Petr Hořava Phys. Rev. D 79, 084008 – Published 6 April 2009

(16) **Petr Hořava** presents a candidate quantum field theory of gravity with (e&eb) dynamical critical exponent equal to z=3 in the UV.
(17) (As in condensed-matter systems, z measures (eb) the degree of anisotropy between space and time.) This theory, which at short distances describes (eb) interacting nonrelativistic gravitons, is (=) power-counting renormalizable in (eb) 3+1 dimension.
(18) When restricted to satisfy the condition of detailed balance,(eb) this theory is intimately related to (e&eb) topologically massive gravity in three dimensions, and the geometry of (e) the Cotton tensor.
(19) At long distances, this theory flows (e&eb) naturally to the relativistic value z=1, and could therefore serve as (=) a possible candidate for (e) a UV completion of Einstein's general relativity or an infrared modification thereof.
(20) The effective speed of light, the Newton constant and the cosmological constant all emerge from (e) relevant deformations of the deeply nonrelativistic z=3 theory at short distances. **Quantum gravity at a Lifshitz point Petr Hořava Phys. Rev. D 79, 084008 – Published 6 April 2009**

Membranes at quantum criticality Petr Hořava1, 2 Published 4 March 2009 • Journal of High Energy Physics, Volume 2009, JHEP03 (2009)

(21) **Petr Hořava1** proposes a quantum theory of membranes designed such that (e) the ground-state wavefunction of the membrane with (e&eb) compact spatial topology Σh reproduces (eb) the partition function of the bosonic string on (e&eb) worldsheet Σh.

(22) The construction involves (e&eb) worldvolume matter at (eb) quantum criticality, described in the simplest case by (e) Lifshitz scalars with (e&eb) dynamical critical exponent z = 2.
(23) This matter system must be coupled to (e&eb) a novel theory of worldvolume gravity, also exhibiting (eb) quantum criticality with z = 2.
(24) Authors first construct such a nonrelativistic ``gravity at a Lifshitz point" with z = 2 in D+1 spacetime dimensions, and then specialize to (e&eb) the critical case of D = 2 suitable for the membrane worldvolume.
(25) They also show that (eb) in the second-quantized framework, the string partition function is reproduced if (e) the spacetime ground state takes the form of (e) a Bose-Einstein condensate of membranes in (eb) their first-quantized ground states, correlated across all general. **Membranes at quantum criticality Petr Hořava1, 2 Published 4 March 2009 • Journal of High Energy Physics, Volume 2009, JHEP03 (2009)**

Heterotic and Type I string dynamics from eleven dimensions Petr Hořavaa, , Edward Wittenb, Nuclear Physics B Volume 460, Issue 3, 12 February 1996, Pages 506–524

(26) **Petr Hořavaa, , Edward Wittenb** propose that the ten-dimensional E8 × E8 heterotic string is related to an eleven-dimensional theory on the orbifold Full-size image (<1 K) in the same way that the Type IIA string in ten dimensions is related to Full-size image (<1 K).
(27) This in particular determines the strong coupling behavior of the ten-dimensional E8 × E8 theory.
(28) It also leads to a plausible scenario whereby duality between SO (32) heterotic and Type I superstrings follows from the classical symmetries of the eleven-dimensional world, just as the Full-size image (<1 K) duality of the ten-dimensional Type IIB theory follows from eleven-dimensional diffeomorphism invariance. **Heterotic and Type I string dynamics from eleven dimensions Petr Hořavaa, , Edward Wittenb, Nuclear Physics B Volume 460, Issue 3, 12 February 1996, Pages 506–524**

The cosmological constant and Hořava-Lifshitz gravity Corrado Appignania,b, Roberto Casadioa,c and S. Shankaranarayananb,d Published 6 April 2010 • Journal of Cosmology and Astroparticle Physics, Volume 2010, April 2010

(29) Hořava-Lifshitz theory of gravity with detailed balance is plagued by (e) the presence of a negative bare (or geometrical) cosmological constant which makes (eb) its cosmology clash with (e&eb) observations.
(30) Authors argue that adding the effects of (e) the large vacuum energy of quantum matter fields, this bare cosmological constant can be approximately compensated to account for (e) the small observed (total) cosmological constant ΛOBS, thus resulting in (eb) a self-contained model of gravity and particle physics.
(31) Even though authors donot cannot address the fine-tuning problem in this way, they establish a relation between the smallness of ΛOBS and (e&eb) the scale ℓUV at which dimension 4 corrections to (e) the Einstein gravity become (eb) significant for cosmology.
(32) This scale turns out to be (eb) ℓUV sime 5 ℓP for ΛOBS sime 0 and authors therefore argue that the smallness of ΛOBS guarantees that (eb) Lorentz invariance is broken only at (eb) very small scales
(33). They provide a first rough estimation for the values of (e) the parameters of the theory μ and ΛW.

Fractal spacetime structure in asymptotically safe gravity Oliver Lauscher1 and Martin Reuter2 Published 17 October 2005 • Journal of High Energy Physics, Volume 2005, JHEP10 (2005)

(34) Four-dimensional Quantum Einstein Gravity (QEG) is likely to be (=) an asymptotically safe theory which is applicable at (e&eb) arbitrarily small distance scales.
(35) On sub-planckian distances it predicts (eb) that spacetime is a fractal with (e&eb) an effective dimensionality of 2.

(36) The original argument leading to (eb) this result was based upon (e) the anomalous dimension of Newton's constant

(37) . In the present paper authors demonstrate that also the spectral dimension equals 2 microscopically, while it is equal to 4 on macroscopic scales.

(38) This result is an exact consequence of asymptotic safety and does not (e) rely on any truncation. Contact is made with recent Monte Carlo simulations.

Hořava-Lifshitz gravity effects on Casimir energy in weak field approximation and infrared regime C. R. Muniz, V. B. Bezerra, and M. S. Cunha Phys. Rev. D 88, 104035 – Published 26 November 2013

(39) Authors calculate the renormalized vacuum energy of (e) a massless scalar field confined between (e&eb) two nearby parallel plates formed by (e) ideal uncharged conductors, placed tangentially to (e) the surface of a sphere with (e&eb) mass M and radius R.

(40) This study will take into account the static and spherically symmetric solution of (e) Hořava-Lifshitz gravity found by (e) Kehagias-Sfetsos (KS), in (eb) both weak field and infrared limits.

(41) A slight amplification of (e) the Casimir force between (e&eb) the conducting plates is found.

(42) Thermal corrections to (e&eb) the Casimir energy are analyzed.

(43) Based on (e) current Casimir effect measurements, a constraint on (e) the ω parameter of KS metric is (=) also obtained. Received 1 October 2013 DOI: http://dx.doi.org/10.1103/PhysRevD.88.104035

The black hole and cosmological solutions in IR modified Hořava gravity Mu-In Park Published 29 September 2009 Journal of High Energy Physics, Volume 2009, JHEP09 (2009)

(44) Recently Hořava proposed a renormalizable gravity theory in (eb) four dimensions which reduces to (e&eb) Einstein gravity with (e&eb) a non-vanishing cosmological constant in (eb) IR but with improved UV behaviors.

(45) Here, I study an IR modification which breaks (e) ``softly'' the detailed balance condition in (eb) Hořava model and allows (eb) the asymptotically flat limit as well.

(46) Author obtains the black hole and cosmological solutions for (e) ``arbitrary'' cosmological constant that represent (eb) the analogs of the standard Schwarzschild-(A)dS solutions which can be (=) asymptotically (A)dS as well as flat and he discusses their thermodynamical properties

(47) Author also obtains solutions for FRW metric with (e&eb) an arbitrary cosmological constant.

(48) He studies its implication to (e&eb) the dark energy and finds (eb) that it seems to be consistent with current observational data.

On the jumping phenomenon of dimCHq (Xt, Et) Kwokwai Chan, Yat-Hin Suen

(49) Let X be a compact complex manifold and E be a holomorphic vector bundle on X. Given a deformation (X,E) of the pair (X,E) over a small polydisk B centered at the origin, authors study the jumping phenomenon of the cohomology groups dimCHq(Xt,Et) near t=0. We show that there are precisely two cohomological obstructions to the stability of dimCHq (Xt, Et), which can be expressed explicitly in terms of the Maurer-Cartan element associated to the deformation. This generalizes the results of X. Ye. Subjects: Differential Geometry (math.DG); Algebraic Geometry (math.AG); Complex Variables (math.CV) Cite as: arXiv: 1601.06472 [math.DG] (or arXiv: 1601.06472v1 [math.DG] for this version)

A differential-geometric approach to deformations of pairs (X, E) Kwokwai Chan, Yat-Hin Suen

(50) This article gives an exposition of the deformation theory for (e) pairs (X, E), where (e) X is a compact complex manifold and E is (=) a holomorphic vector bundle over X, adapting (e&eb) an analytic viewpoint \`{a} la Kodaira-Spencer.

(51) By introducing and exploiting an auxiliary differential operator, we derive the Maurer--Cartan equation and differential graded Lie algebra (DGLA) governing the deformation problem, and express them in terms of differential-geometric notions such as the connection and curvature of E, obtaining a chain level refinement of the classical results that the tangent space and obstruction space of the moduli problem are respectively given by the first and second cohomology groups of the Atiyah extension of E over X. As an application, we give examples where deformations of pairs are unobstructed Subjects: Differential Geometry (math.DG); Complex Variables (math.CV) Journal reference: Complex Manifolds 3 (2016), 16-40 DOI: 10.1515/coma-2016-0002 Cite as: arXiv:1406.6753 [math.DG] (or arXiv:1406.6753v4 [math.DG] for this version)

Dynamic Service Migration in Mobile Edge-Clouds Shiqiang Wang, Rahul Urgaonkar, Murtaza Zafer, Ting He, Kevin Chan, Kin K. Leung

(52) Authors study the dynamic service migration problem in mobile edge-clouds that host cloud-based services at the network edge. This offers the benefits of reduction in network overhead and latency but requires service migrations as user locations change over time. It is challenging to make these decisions in an optimal manner because of the uncertainty in node mobility as well as possible non-linearity of the migration and transmission costs. In this paper, we formulate a sequential decision making problem for service migration using the framework of Markov Decision Process (MDP). Our formulation captures general cost models and provides a mathematical framework to design optimal service migration policies. In order to overcome the complexity associated with computing the optimal policy, we approximate the underlying state space by the distance between the user and service locations. We show that the resulting MDP is exact for uniform one-dimensional mobility while it provides a close approximation for uniform two-dimensional mobility with a constant additive error term. We also propose a new algorithm and a numerical technique for computing the optimal solution which is significantly faster in computation than traditional methods based on value or policy iteration. We illustrate the effectiveness of our approach by simulation using real-world mobility traces of taxis in San Francisco. Comments: in Proc. of IFIP Networking 2015Subjects: Distributed, Parallel, and Cluster Computing (cs.DC); Networking and Internet Architecture (cs.NI); Optimization and Control (math.OC) Cite as: arXiv: 1506.05261 [cs.DC] (or arXiv: 1506.05261v1 [cs.DC] for this version)

Modules of constant Jordan type, pullbacks of bundles and generic kernel filtrations Shawn Baland, Kenneth Chan

(53) Let kE denote the group algebra of an elementary abelian p-group of rank r over an algebraically closed field of characteristic p. We investigate the functors Fi from kE-modules of constant Jordan type to vector bundles on Pr−1(k), constructed by Benson and Pevtsova. For a kE-module M of constant Jordan type, we show that restricting the sheaf Fi(M) to a dimension s−1 linear subvariety of Pr−1(k) is equivalent to restricting M along a corresponding rank s shifted subgroup of kE and then applying Fi. In the case r=2, we examine the generic kernel filtration of M in order to show that Fi(M) may be computed on certain sub quotients of M whose Loewy lengths are bounded in terms of i. More precise information is obtained by applying similar techniques to the nth power generic kernel filtration of M. The latter approach also allows us to generalise our results to higher ranks r. Subjects: Representation Theory (math.RT) MSC classes: 16G10, 20C20 Cite as: arXiv: 1504.01994 [math.RT] (or arXiv: 1504.01994v1 [math.RT] for this version)

Mobility-Induced Service Migration in Mobile Micro-Clouds Shiqiang Wang, Rahul Urgaonkar, Ting He, Murtaza Zafer, Kevin Chan, Kin K. Leung

(54) Mobile micro-cloud is an emerging technology in distributed computing, which is aimed at providing seamless computing/data access to the edge of the network when a centralized service may suffer from poor connectivity and long latency. Different from the traditional cloud, a mobile micro-cloud is smaller and deployed closer to users, typically attached to a cellular basestation or wireless network access point. Due to the relatively small coverage area of each basestation or access point, when a user moves across areas covered by different base stations or access points which are attached to different micro-clouds, issues of service performance and service migration become important. In this paper, we consider such migration issues. We model the general problem as a Markov decision process (MDP), and show that, in the special case where the mobile user follows a one-dimensional asymmetric random walk mobility model, the optimal policy for service migration is a threshold policy. We obtain the analytical solution for the cost resulting from arbitrary thresholds, and then propose an algorithm for finding the optimal thresholds. The proposed algorithm is more efficient than standard mechanisms for solving MDPs. Comments: in Proc. of IEEE MILCOM 2014, Oct. 2014 Subjects:Distributed, Parallel, and Cluster Computing (cs.DC); Networking and Internet Architecture (cs.NI); Optimization and Control (math.OC) DOI: 10.1109/MILCOM.2014.145 Cite as: arXiv: 1503.05141 [cs.DC] (or arXiv: 1503.05141v1 [cs.DC] for this version)

Dynamic Service Placement for Mobile Micro-Clouds with Predicted Future Costs Shiqiang Wang, Rahul Urgaonkar, Kevin Chan, Ting He, Murtaza Zafer, Kin K. Leung

(55) Seamless computing and data access is enabled by the emerging technology of mobile micro-clouds (MMCs). Different from traditional centralized clouds, an MMC is typically connected directly to a wireless base-station and provides services to a small group of users, which allows users to have instantaneous access to cloud services. Due to the limited coverage area of base-stations and the dynamic nature of mobile users, network background traffic, etc., the question of where to place the services to cope with these dynamics arises. In this paper, we focus on dynamic service placement for MMCs. We consider the case where there is an underlying mechanism to predict the future costs of service hosting and migration, and the prediction error is assumed to be bounded. Our goal is to find the optimal service placement sequence which minimizes the average cost over a given time. To solve this problem, we first propose a method which solves for the optimal placement sequence for a specific look-ahead time-window, based on the predicted costs in this time-window. We show that this problem is equivalent to a shortest-path problem and propose an algorithm with polynomial time-complexity to find its solution. Then, we propose a method to find the optimal look-ahead window size, which minimizes an upper bound of the average cost. Finally, we evaluate the effectiveness of the proposed approach by simulations with real-world user-mobility traces. Comments: in Proc. of IEEE ICC 2015 Subjects: Distributed, Parallel, and Cluster Computing (cs.DC); Networking and Internet Architecture (cs.NI); Optimization and Control (math.OC) Cite as: arXiv: 1503.02735 [cs.DC] (or arXiv: 1503.02735v1 [cs.DC] for this version)

A mathematical foundation of Rozansky-Witten theory Kwokwai Chan, Naichung Conan Leung, Qin Li

(56) Authors give a mathematically rigorous construction of Rozansky-Witten's 3-dimensional σ-model as a perturbative quantum field theory (QFT) by applying Costello's approach using the Batalin-Vilkovisky (BV) formalism. The quantization of our model is obtained via the technique of configuration spaces. We also investigate the observable theory following the work of Costello-Gwilliam. In particular, we show that the cohomology of local quantum observables on a genus g handle body is given by $H*(X,(\wedge*TX)\otimes g)$, where X is the target hyperk\"ahler manifold. We further give a mathematical definition of the partition function and prove that it coincides with the Rozansky-Witten invariants. Subjects: Quantum Algebra (math.QA); High Energy Physics - Theory (hep-th); Algebraic Geometry (math.AG); Differential

Geometry (math.DG); Geometric Topology (math.GT) Cite as: arXiv:1502.03510 [math.QA] (or arXiv:1502.03510v1 [math.QA] for this version)

Compactification (physics) From Wikipedia, the free encyclopedia

(57) In physics, compactification means changing a theory with respect to one of its space-time dimensions. Instead of having a theory with this dimension being infinite, one changes the theory so that this dimension has a finite length, and may also be periodic. Compactification plays an important part in thermal field theory where one compactifies time, in string theory where one compactifies the extra dimensions of the theory, and in two- or one-dimensional solid state physics, where one considers a system which is limited in one of the three usual spatial dimensions. At the limit where the size of the compact dimension goes to zero, no fields depend on this extra dimension, and the theory is dimensionally reduced.

Compactification in string theory

(58) In string theory, compactification is a generalization of Kaluza–Klein theory. It tries to conciliate the gap between the conceptions of our universe based on its four observable dimensions with the ten, eleven, or twenty-six dimensions which theoretical equations lead us to suppose the universe is made with.

(59) For this purpose it is assumed the extra dimensions are "wrapped" up on themselves, or "curled" up on Calabi–Yau spaces, or on orbifolds. Models in which the compact directions support fluxes are known as flux compactifications. The coupling constant of string theory, which determines the probability of strings to split and reconnect, can be described by a field called dilaton. This in turn can be described as the size of an extra (eleventh) dimension which is compact. In this way, the ten-dimensional type IIA string theory can be described as the compactification of M-theory in eleven dimensions. Furthermore, different versions of string theory are related by different compactifications in a procedure known as T-duality. The formulation of more precise versions of the meaning of compactification in this context has been promoted by discoveries such as the mysterious duality.

Flux compactification

(60) A flux compactification is a particular way to deal with additional dimensions required by string theory. It assumes that the shape of the internal manifold is a Calabi–Yau manifold or generalized Calabi–Yau manifold which is equipped with non-zero values of fluxes, i.e. differential forms that generalize the concept of an electromagnetic field (see p-form electrodynamics).The hypothetical concept of the anthropic landscape in string theory follows from a large number of possibilities in which the integers that characterize the fluxes can be chosen without violating rules of string theory. The flux compactifications can be described as F-theory vacua or type IIB string theory vacua with or without D-branes.

Noncommutative perturbative dynamics Shiraz Minwalla1, Mark Van Raamsdonk1 and Nathan Seiberg2 Published 15 March 2000 • Journal of High Energy Physics, Volume 2000, JHEP02 (2000)

(61) **Shiraz Minwalla1, Mark Van Raamsdonk1 and Nathan Seiberg2** study the perturbative dynamics of (e) noncommutative field theories on (eb) Script Rd, and find (eb) an intriguing mixing of the UV and the IR.
(62) High energies of virtual particles in loops produce (eb) non-analyticity at low momentum.
(63) Consequently, the low energy effective action is (=) singular at zero momentum even when (e) the original noncommutative field theory is (=) massive.
(64) Some of the nonplanar diagrams of (e) these theories are (=) divergent, but they interpret these divergences as (=) IR divergences and deal with (e&eb) them accordingly.
(65) Authors explain how this UV/IR mixing arises from (e) the underlying noncommutativity.
(66) This phenomenon is reminiscent of (e) the channel duality of (e) the double twist diagram in (eb)open string theory.

The gravitational Hamiltonian, action, entropy and surface terms S W Hawking and Gary T Horowitz Classical and Quantum Gravity, Volume 13, Number 6 http://dx.doi.org/10.1088/0264-9381/13/6/017

(67) Authors give a derivation of the gravitational Hamiltonian starting from (e) the Einstein - Hilbert action, keeping track of (e) all surface terms.
(68) This derivation can be applied to (e&eb) any spacetime that asymptotically approaches (eb) a static background solution.
(69) The surface term that arises in (eb) the Hamiltonian can be taken as (=) the definition of the `total energy', even for (e) spacetimes that are not (e) asymptotically flat.
(70) (In the asymptotically flat case, it agrees with (eb) the usual ADM energy.)
(71) They also discuss the relation between the Euclidean action and (e&eb) the Hamiltonian when (e) there are horizons of infinite area (e.g. acceleration horizons) as well as (e&eb) the usual finite area black hole horizons.
(72) Acceleration horizons seem to be (=) more analogous to (e) extreme than nonextreme black holes, since they find evidence that their horizon area is not (e) related to the total entropy.

ARUN SAHNI and ALEXEI STAROBINSKY, Int. J. Mod Phys. D 09, 373 (2000) DOI: 10.1142/S0218271800000542 THE CASE FOR A POSITIVE COSMOLOGICAL Λ-TERM

(73) Recent observations of Type 1a supernovae indicating (eb) an accelerating universe have (e) once more drawn attention to the possible existence, at the present epoch, of (e) a small positive Λ-term (cosmological constant).
(74) In this paper authors review both observational and theoretical aspects of (e) a small cosmological Λ-term.
(75) Authors discuss the current observational situation focusing on cosmological tests of Λ including (e) the age of the universe, high redshift supernovae (e&eb) gravitational lensing (e&eb) galaxy clustering and (e&eb) the cosmic microwave background.
(76) They also review the theoretical debate surrounding Λ: the generation of Λ in models with (e&eb) spontaneous symmetry breaking and through(e&eb) quantum vacuum polarization effects — mechanisms which are known to give rise to (eb) a large value of Λ hence leading to (eb) the "cosmological constant problem."
(77) More recent attempts to generate (eb) a small cosmological constant at the present epoch using (e) either field theoretic techniques or by (e) modelling a dynamical Λ-term by scalar fields are also extensively discussed.
(78) Anthropic arguments favouring a small Λ-term are briefly reviewed. A comprehensive bibliography of recent work on Λ is provided.

Cosmological constraints on fast transition unified dark energy and dark matter models Ruth Lazkoz, Iker Leanizbarrutia, and Vincenzo Salzano Phys. Rev. D 93, 043537 – Published 22 February 2016

(79) Authors explore the observational adequacy of (e) a class of unified dark energy and dark matter (UDE/M) models with (e&eb) a fast transition.
(80) Constraints are set using (e) a combination of geometric probes—some low redshift ones and (e&eb) some high redshift ones (CMB-related included).
(81) The transition is phenomenologically modeled by (e) two different transition functions corresponding to (e&eb) a fast and to an ultrafast transition, respectively.
(82) They find that the key parameters governing (e&eb) the transition can be (=) well constrained, and from (e) the statistical point of view it follows (eb) that the models cannot be discarded when compared to (e&eb) LCDM.
(83) Authors find the intriguing result that standard or input parameters such as Ωm and Ωb are (=) far better constrained than in (eb) LCDM, and this is the case for (e) the derived or output parameter measuring (eb)

the deceleration value at present, q0. DOI: http://dx.doi.org/10.1103/PhysRevD.93.043537 © 2016 American Physical Society

Stochastic quintessence models: Jerk and fine-structure variability constraints Christine C. Dantas and André L. B. Ribeiro Phys. Rev. D 93, 043509 – Published 8 February 2016

(84) Authors report on constraints to (e) the cosmological jerk parameter (j) and to possible variability of (e) the fine-structure constant (Δα/α) based on (e) stochastic quintessence models of (e) dark energy, discussed by Chongchitnan and Efstathiou [Phys. Rev. D 76, 043508 (2007)].

(85) Authors confirm the results by (e) these authors in the sense that many viable solutions can be obtained, obeying (e&eb) current observational constraints in low redshifts.

(86) They add the observables j and Δα/α to (e&eb) this conclusion.

(87) However, they find peculiarities that may produce (eb) in the nearby universe, potential observational imprints in (eb) future cosmological data.

(88) Authors conclude, for redshifts z≲3, that (i) j(z) fluctuates due to (e&eb) the stochasticity of the models, reaching (eb) an amplitude of up to 5% relatively to (e&eb) the Λ cold dark matter model value (jΛCDM=1); and (ii) by contrasting two distinct ("extreme") types of solutions, variabilities in α(z), linked to (e&eb) a linear coupling (ζ) between the dark energy and (e&eb) electromagnetic sectors, are (eb) weakly dependent on redshift, for (e) couplings of the order |ζ|∼10−4, even for (e) large variations in the equation of state parameter at (eb) relatively low redshifts. Nonlinear couplings produce (eb) an earlier and steeper onset of (e) the evolution in Δα/α (z), but can still accommodate (e) the data for weak enough couplings. DOI: http://dx.doi.org/10.1103/PhysRevD.93.043509 © 2016 American Physical Society

The Void Galaxy Survey: Star Formation Properties B. Beygu1,6,★, K. Kreckel2, J. M. van der Hulst1, T. H Jarrett3, R. Peletier1, R. van de Weygaert1, J. H. van Gorkom4 and M. A. Aragon-Calvo5

(89) Authors study the star formation properties of 59 void galaxies as part of the Void Galaxy Survey (VGS). Current star formation rates are derived from (e) $\rm {H\alpha} $ and recent star formation rates from (e) near-UV imaging.

(90) In addition, infrared 3.4 $\rm {\mu m}$, 4.6 $\rm {\mu m}$, 12 $\rm {\mu m}$ and 22 $\rm {\mu m}$ WISE emission is used as (=) star formation and mass indicator

(91) Infrared and optical colours show that (eb) the VGS sample displays (eb) a wide range of dust and metallicity properties.

(92) They combine these measurements with (e&eb) stellar and $\rm {H\small {I}} $ masses to measure (eb) the specific SFRs ($\rm {SFR/M_ {*}} $) and (e&eb) star formation efficiencies ($\rm {SFR/M_ {H\small {I}}}$).

(93) Authors compare the star formation properties of their sample with (e&eb) galaxies in (eb) the more moderate density regions of (e) the cosmic web, 'the field'.

(94) They find that specific SFRs of (e) the VGS galaxies as (=) a function of stellar and $\rm {H\small {I}}$ mass are similar to (e&eb, =) those of the galaxies in these field regions.

(95) Their $\rm {SFR\alpha} $ is slightly elevated than (e) the galaxies in the field for (e) a given total $\rm {H\small {I}} $ mass.

(96) In the global star formation picture presented by (e) Kennicutt-Schmidt, VGS galaxies fall into (eb)the regime of low average star formation and correspondingly (e&eb) low $\rm {H\small {I}} $ surface density.

(97) Their mean $\rm {SFR\alpha /M_{H\small {I}}}$ and (e&eb) $\rm {SFR\alpha /M_{*}}$ are of (e) the order of $\rm {10^{-9.9}}$ $\rm {yr^{-1}}$.

(98) Authors conclude that while the large scale underdense environment must play (e&eb) some role in galaxy formation and growth through accretion, they find that even with respect to other galaxies in the more mildly underdense regions, the increase in star formation rate is (=) only marginal. Key words galaxies: star

formation galaxies: formation —galaxies: structure large-scale structure of universe© 2016 The Authors Published by Oxford University Press on behalf of the Royal Astronomical Society

Assembly of filamentary void galaxy configurations Steven Rieder1, 2, Rien van de Weygaert3, Marius Cautun3, Burcu Beygu3 and Simon Portegies Zwart1First published online August 20, 2013

(99) Authors study the formation and evolution of (e) filamentary configurations of dark matter haloes in (eb) voids.
(100) Extant investigation uses (e) the high-resolution Λ cold dark matter simulation Cosmo Grid to (e) look for (e) void systems resembling the VGS_31 elongated system of (e) three interacting galaxies that was recently discovered by (e) the Void Galaxy Survey inside (eb) a large void in the Sloan Digital Sky Survey galaxy redshift survey.
(101) H I data revealed these galaxies to be embedded in (eb) a common elongated envelope, possibly embedded in (eb) intravoid filament.
(102) In the Cosmo Grid simulation authors look for systems similar to (e) VGS_31 in mass, size and environment. They find (eb) a total of eight such systems.
(103) For these systems, authors study the distribution of (e) neighbour haloes, the assembly and evolution of (e) the main haloes and (e&eb) the dynamical evolution of the haloes, as well as the evolution of (e) the large-scale structure in which the systems are (=) embedded.
(104) The spatial distribution of the haloes follows that of (e&eb) the dark matter environment.
(105) Authors find that VGS_31-like systems have (e) a large variation in formation time, having (e) formed between (e&eb) 10 Gyr ago and the present epoch.
(106) However, the environments in which the systems are embedded evolved to (e) resemble each other substantially.
(107) Each of the VGS_31-like systems is embedded in (eb) an intravoid wall, that no later than z = 0.5 became the only prominent feature in its environment.
(108) While parts of the void walls retain (eb) a rather featureless character, authors find that around half of them are marked by (e) a pronounced and rapidly evolving substructure.
(109) Five haloes find themselves in a tenuous filament of a few h−1 Mpc long inside (eb) the intravoid wall.
(110) Finally, authors compare the results to (e&eb) observed data from VGS_31.
(111) Study implies that (eb) the VGS_31 galaxies formed in (eb) the same (proto) filament, and did not (e) meet just recently.
(112) The diversity amongst the simulated halo systems indicates (eb) that VGS_31 may not (e) be typical for (e) groups of galaxies in voids.
(113) Key words galaxies: formation galaxies: interactions cosmology (e&eb) theory dark matter large-scale structure of Universe © 2013 The Authors Published by Oxford University Press on behalf of the Royal Astronomical Society

On the Star Formation Properties of Void Galaxies Crystal M. Moorman, Jackeline Moreno, Amanda White, Michael S. Vogeley, Fiona Hoyle, Riccardo Giovanelli, Martha P. Haynes

(114) Authors measure the star formation properties of (e) two large samples of galaxies from (e) the SDSS in large-scale cosmic voids on (e&eb) time scales of 10 Myr and 100 Myr, using (e) Hα emission line strengths and GALEX FUV fluxes, respectively.
(115) The first sample consists of 109,818 optically selected galaxies. They find that void galaxies in this sample have (e) higher specific star formation rates (SSFRs; star formation rates per unit stellar mass) than (e&eb) similar stellar mass galaxies in (eb) denser regions.
(116) The second sample is (=) a subset of (e) the optically selected sample containing (e) 8070 galaxies with (e&eb) reliable HI detections from ALFALFA.

(117) For the full HI detected sample, SSFRs do not (e) vary systematically with (e&eb) large-scale environment.

(118) However, investigating only the HI detected dwarf galaxies reveals (eb) a trend towards higher SSFRs in (eb) voids.

(119) Furthermore, authors estimate the **star formation** rate per unit HI mass (known as the star formation efficiency; SFE) of a galaxy, as (=) a **function of environment**.

(120) For the overall HI detected population, authors notice no (e) environmental dependence. (AC=DC=0)

(121) Limiting the sample to dwarf galaxies again reveals (eb) a trend towards higher SFEs in (eb) voids.

(122) These results suggest (eb) that void environments provide (eb) a nurturing environment for (e) dwarf galaxy evolution allowing (eb) for higher specific star formation rates and efficiencies. Comments: submitted to ApJ 12-2015 Subjects: Astrophysics of Galaxies (astro-ph.GA) Cite as:arXiv: 1601.04092 [astro-ph.GA]

The Optical Luminosity Function of Void Galaxies in the SDSS and ALFALFA Surveys Crystal M. Moorman, Michael S. Vogeley, Fiona Hoyle, Danny C. Pan, Martha P. Haynes, Riccardo Giovanelli

(123) Authors measure the r-band galaxy luminosity function (LF) across environments over the redshift range $0<z<0.107$ using the SDSS. Authors divide sample into (e&eb) galaxies residing in (eb) large scale voids (void galaxies) and (e&eb) those residing in (eb) denser regions (wall galaxies).

(124) The best fitting Schechter parameters for (e) void galaxies are: $\log \Phi_* = -3.40\pm0.03$ log (Mpc−3), $M_* = -19.88\pm0.05$, and $\alpha=-1.20\pm0.02$.

(125) For wall galaxies, the best fitting parameters are: $\log\Phi_*=-2.86\pm0.02$ log (Mpc−3), $M_*=-20.80\pm0.03$, and $\alpha=-1.16\pm0.01$.

(126) Authors find a shift in the characteristic magnitude, M_*, towards fainter magnitudes for (e) void galaxies and find (eb) no significant difference between the faint-end slopes of the void and (e&eb) wall galaxy LFs

(127) Authors investigate how low surface brightness selections effects can affect the (e&eb) galaxy LF.

(128) To attempt to examine a sample of galaxies that is relatively free of (e) surface brightness selection effects, Authors compute the optical galaxy LF of (e) galaxies detected by (e) the blind HI survey, ALFALFA.

(129) Authors find that the global LF of (e) the ALFALFA sample is not well fit by (e) a Schechter function, because of (e) the presence of a wide dip in (eb) the LF around $M_r=-18$ and an upturn at (eb) fainter magnitudes ($\alpha\sim-1.47$).

(130) Authors compare the HI selected r-band LF to (e&eb) various LFs of optically selected populations to determine where (e) the HI selected optical LF obtains its shape.

(131) Authors find that sample selection plays a (e&eb) large role in determining the shape of the LF. Subjects: Astrophysics of Galaxies (astro-ph.GA) Journal reference: The Astrophysical Journal, Volume 810, p.108, 3 September 2015 DOI:10.1088/0004-637X/810/2/108 Cite as: arXiv: 1508.04199 [astro-ph.GA] (or arXiv:1508.04199v1 [astro-ph.GA] for this version)

The HI Mass Function and Velocity Width Function of Void Galaxies in the Arecibo Legacy Fast ALFA Survey Crystal M. Moorman, Michael S. Vogeley, Fiona Hoyle, Danny C. Pan, Martha P. Haynes, Riccardo Giovanelli

(132) Authors measure the HI mass function (HIMF) and (e&eb) velocity width function (WF) across (e&eb) environments over (e&eb) a range of masses $7.2<\log(M_{HI}/M_\odot)<10.8$, and profile widths $1.3\log(km/s)<\log(W)<2.9\log(km/s)$, using (e) a catalog of ~7,300 HI-selected galaxies from (e) the

ALFALFA Survey, located in (eb) the region of sky where (e) ALFALFA and SDSS (Data Release 7) North overlap.

(133) Authors divide (e&eb) galaxy sample into those that reside in (eb) large-scale voids (void galaxies) and those that live in (eb) denser regions (wall galaxies).

(134) Authors find the void HIMF to be well fit by (e) a Schechter function with (e&eb) normalization Φ∗=(1.37±0.1)×10−2h3Mpc−3, characteristic mass log(M∗/M⊙)+2logh70=9.86±0.02, and (e&eb) low-mass-end slope α=−1.29±0.02.

(135) Similarly, for wall galaxies, Authors find best-fitting parameters Φ∗=(1.82±0.03)×10−2h3Mpc−3, log(M∗/M⊙)+2logh70=10.00±0.01, and α=−1.35±0.01.

(136) Authors conclude that void galaxies typically have (e) slightly lower HI masses than (eb) their non-void counterparts, which is (=) in agreement with the dark matter halo mass function shift in (eb) voids assuming a simple relationship between DM mass (e&eb) and HI mass.

(137) Authors also find that the low-mass slope of the void HIMF is similar to (e) that of the wall HIMF suggesting that (eb) there is either no excess of low-mass galaxies in (eb) voids or there is (=) an abundance of intermediate HI mass galaxies.

(138) Authors fit a modified Schechter function to (e) the ALFALFA void WF and determine (eb) its best-fitting parameters to be Φ∗=0.21±0.1h3Mpc−3, log (W∗)=2.13±0.3, α=0.52±0.5 and (e&eb) high-width slope β=1.3±0.4.

(139) For wall galaxies, the WF parameters are: Φ∗=0.022±0.009h3Mpc−3, log (W∗)=2.62±0.5, α=−0.64±0.2 and β=3.58±1.5.

(140) Because of large uncertainties on (eb) the void and wall width functions, Authors cannot conclude whether the WF is dependent on (e&eb) the environment. Subjects: Astrophysics of Galaxies (astro-ph.GA); Cosmology and Nongalactic Astrophysics (astro-ph.CO) Journal reference: Monthly Notices of the Royal Astronomical Society 2014, Volume 444, Issue 2: p.3559-3570 DOI:10.1093/mnras/stu1674 Cite as: arXiv: 1408.3392 [astro-ph.GA] (or arXiv: 1408.3392v2 [astro-ph.GA] for this version)

Mapping galaxy encounters in numerical simulations: The spatial extent of induced star formation Jorge Moreno, Paul Torrey, Sara L. Ellison, David R. Patton, Asa F. L. Bluck, Gunjan Bansal, Lars Hernquist

(141) Authors employ a suite of 75 simulations of galaxies in (eb) idealised major mergers (stellar mass ratio ~2.5:1), with (e&eb) a wide range of orbital parameters, to investigate the spatial extent of (e) interaction-induced star formation.

(142) Although the total star formation in galaxy encounters is generally elevated relative to (e&eb) isolated galaxies, Authors find that this elevation is (=) a combination of intense enhancements within (eb) the central kpc and moderately suppressed activity at (eb) large galacto-centric radii.

(143) The radial dependence of the star formation enhancement is (=) stronger in (eb) the less massive galaxy than (eb) in the primary, and is (=) also more pronounced in (eb) mergers of (e) more closely aligned (e&eb) disc spin orientations.

(144) Conversely, these trends are almost entirely independent of (e) the encounters impact parameter and (e&eb) orbital eccentricity.

(145) Predictions of the radial dependence of (e) triggered star formation, and specifically the suppression of (e) star formation beyond kph-scales, will be testable with (e&eb) the next generation of integral-field spectroscopic surveys. Subjects: Astrophysics of Galaxies (astro-ph.GA); Cosmology and Nongalactic Astrophysics (astro-ph.CO) DOI:10.1093/mnras/stv094 Cite as: arXiv: 1501.03573 [astro-ph.GA] (or arXiv: 1501.03573v1 [astro-ph.GA] for this version)

Halo Pairs in the Millennium Simulation: Love & Deception Jorge Moreno (Submitted on 30 Nov 2011)

(146) In this work author investigates the statistical properties of (e) a huge catalog of closely interacting pairs of (e&eb) dark matter haloes, extracted from (e) the Millennium Simulation database.

(147) Only haloes that reach (eb) a minimum mass greater than (eb) 8.6 \times 10^10 Msun/h (corresponding to 100 particles) are considered.

(148) Close pairs are selected if (e) they come within (eb) a critical distance dcrit

(149) Author explores the effects of (e&eb) replacing dcrit = 1 Mpc/h with (e&eb) 200 kpc/h on (eb) the evolution of separations (e&eb) lifetimes (e&eb) total masses and (e&eb) mass ratios of these pairs. Subjects: Cosmology and Nongalactic Astrophysics (astro-ph.CO) Cite as:arXiv:1112.0010 [astro-ph.CO] (or arXiv:1112.0010v1 [astro-ph.CO] for this version)

Classical Oe Stars in the Field of the Small Magellanic Cloud Jesse B. Golden-Marx (1), M. S. Oey (1), J. B. Lamb (2), Andrew S. Graus (3), Aaron S. White (1) ((1) U. Michigan, (2) Nassau Community College, (3) UC Irvine)

(150) Authors present 29±1 classical Oe stars from RIOTS4, a spatially complete, spectroscopic survey of Small Magellanic Cloud (SMC) field OB stars. The two earliest are O6e stars, and four are earlier than any Milky Way (MW) Oe stars. Authors also find ten Ope stars, showing (eb) He~\textsc{i} infill and/or emission; five appear to be (=) at least as hot as ∼O7.5e stars.

(151) The hottest, star 77616, shows (eb) He~\textsc{ii} disk emission, suggesting (eb) that even the hottest O stars can form (eb) decretion disks, and offers (eb) observational support for (e) theoretical predictions that the hottest, fastest rotators can generate (eb) He+-ionizing atmospheres.

(152) Data also demonstrate that Ope stars correspond to (e&eb) Oe stars earlier than O7.5e with (e&eb) strong disk emission.

(153) Authors find that in the SMC, Oe stars extend to (e&eb) earlier spectral types than in (eb) the MW, and our SMC Oe/O frequency, 0.26±0.04, is much greater than (e) the MW value, 0.03±0.01.

(154) These results are consistent with (e&eb) angular momentum transport by (e) stronger winds suppressing (e) decretion disk formation at higher metallicity.

(155) In addition, our SMC field Oe star frequency is (=) indistinguishable from (e) that for clusters, which is consistent with (e&eb) the similarity between rotation rates in these environments, and contrary to (eb&e) the pattern for MW rotation rates.

(156) Thus, findings strongly support (eb) the viscous decretion disk model and confirm (eb) that Oe stars are (=) the high-mass extension of the Be phenomenon.

(157) Additionally, Authors find that Fe~\textsc{ii} emission occurs among (e&eb) Oe stars later than O7.5e with massive disks, and Authors revise a photometric criterion for (e) identifying Oe stars to J−[3.6]≥0.1. Subjects: Solar and Stellar Astrophysics (astro-ph.SR) Cite as:arXiv:1601.03405 [astro-ph.SR] (or arXiv:1601.03405v1 [astro-ph.SR] for this version)

Spectral Properties of Galaxies in Void Regions Chenxu Liu, Danny Pan, Lei Hao, Fiona Hoyle, Anca Constantin, and Micheal S. Vogeley (Submitted on 15 Sep 2015)

(158) Authors present a study of spectral properties of (e) galaxies in underdense large-scale structures, voids.

(159) Our void galaxy sample (75,939 galaxies) is selected from (e) the Sloan Digital Sky Survey (SDSS) Data Release 7 (DR7) with z<0.107.

(160) Authors find that there are no significant differences in the luminosities, stellar masses, stellar populations, and specific star formation rates between (e&eb) void galaxies of specific spectral types and their wall counterparts

(161) However, the fraction of star-forming galaxies in voids is (=) significantly higher (≥9%) than that in (eb) walls.

(162) Void galaxies, when considering all spectral types, are (=) slightly fainter, less massive, have younger stellar populations and of higher specific star formation rates than (e) wall galaxies.

(163) These minor differences are totally caused by (e) the higher fraction of (e) star-forming galaxies in voids.

(164) Authors confirm that AGNs exist in (eb) voids, already found by (e) \cite{co08}, with similar abundance as (=) in walls.

(165) Type I AGNs contribute ~ 1\%-2\% of void galaxies, similar to their fraction in walls. The intrinsic [O III] luminosities, spanning over (e&eb) $10^6\ L_ {\sun} \sim 10^9\ L_ {\sun}$, and Eddington ratios are similar comparing Authors void AGNs versus wall AGNs.

(166) Small scale statistics show that all spectral types of void galaxies are less clustered than their (e&eb) counterparts in walls.

(167) Major merger may not be (=) the dominant trigger of (e) black hole accretion in (eb) the luminosity range they probe.

(168) Authors study implies (eb) that the growth of black holes relies weakly on (e) large scale structures. Subjects: Astrophysics of Galaxies (astro-ph.GA) DOI: 10.1088/0004-637X/810/2/165 Cite as: arXiv: 1509.04430 [astro-ph.GA] (or arXiv: 1509.04430v1 [astro-ph.GA] for this version)

Do the Kepler AGN Light Curves Need Re-processing? Vishal P. Kasliwal, Michael S. Vogeley, Gordon T. Richards, Joshua Williams, Michael T. Carini (Submitted on 15 Jul 2015)

(169) Authors gauge the impact of spacecraft-induced effects on (e&eb) the inferred variability properties of (e) the light curve of the Seyfert 1 AGN Zw 229-15 observed by (e) \Kepler. Authors compare the light curve of Zw 229-15 obtained from (e) the Kepler MAST database with (e&eb) a re-processed light curve constructed from (e) raw pixel data (Williams & Carini, 2015). Authors use the first-order structure function, SF (δt), to fit both light curves to (e) the damped power-law PSD of Kasliwal, Vogeley & Richards, 2015. On short timescales, we find a steeper log-PSD slope (γ=2.90 to within 10 percent) for the re-processed light curve as compared to the light curve found on MAST (γ=2.65 to within 10 percent) --- both inconsistent with (e&eb) a damped random walk which requires (e) γ=2. The log-PSD slope inferred for (e) the re-processed light curve is consistent with (=) previous results (Carini & Ryle, 2012, Williams & Carini, 2015) that study the same re-processed light curve.

(170) The turnover timescale is almost identical for (e) both light curves (27.1 and 27.5~d for the reprocessed and MAST database light curves).

(171) Based on (e) the obvious visual difference between (e&eb)the two versions of the light curve and (e&eb) on the PSD model fits, Authors conclude that there remain significant levels of spacecraft-induced effects in (eb) the standard pipeline reduction of the Kepler data.

(172) Re-processing the light curves will change the model inferenced from the data but is unlikely to change (e&eb) the overall scientific conclusion reached by (e) Kasliwal et al. 2015---not all AGN light curves are consistent with (e&eb, =) the DRW. (astro-ph.GA); High Energy Astrophysical Phenomena (astro-ph.HE) Journal reference: Monthly Notices of the Royal Astronomical Society 2015 453 (2): 2075-2081 DOI:10.1093/mnras/stv1797 Cite as: arXiv: 1507.04251 [astro-ph.GA] (or arXiv: 1507.04251v1 [astro-ph.GA] for this version)

Are the Variability Properties of the Kepler AGN Light Curves Consistent with a Damped Random Walk? Vishal P. Kasliwal, Michael S. Vogeley, Gordon T. Richards

(173) Authors test the consistency of active galactic nuclei (AGN) optical flux variability with (e&eb) the damped random walk (DRW) model. Sample consists of (e) 20 multi-quarter Kepler AGN light curves including (e) both Type 1 and 2 Seyferts, radio-loud and -quiet AGN, quasars, and blazars. Kepler observations of AGN light curves offer (eb) a unique insight into (e&eb) the variability properties of AGN light curves because of (e) the very rapid (11.6−28.6 min) and highly uniform rest-frame sampling combined with (e&eb) a photometric precision of 1 part in 105 over (e&eb) a period of 3.5 yr. Authors categorize (e&eb) the light curves of all 20 objects based on (e) visual similarities and find that (eb)the light curves fall into 5 broad categories

(174) . Authors measure (eb) the first order structure function of these light curves and model the observed light curve with (e&eb) a general broken power-law PSD characterized by (e) a short-timescale power-law index γ and turnover timescale τ.

(175) Authors find that less than half the objects are consistent with a DRW and observe variability on short timescales (∼2 h). The turnover timescale τ ranges from ∼10−135 d. Interesting structure function features include pronounced dips on rest-frame timescales ranging from 10−100 d and varying slopes on different timescales.

(176) The range of observed short-timescale PSD slopes and the presence of dip and varying slope features suggests (eb) that the DRW model may not be (=) appropriate for all AGN. Authors conclude that AGN variability is (=) a complex phenomenon that requires (e) a more sophisticated statistical treatment. Subjects: Astrophysics of Galaxies (astro-ph.GA); Instrumentation and Methods for Astrophysics (astro-ph.IM) Journal reference: Monthly Notices of the Royal Astronomical Society 2015 451 (4): 4328-4345 DOI:10.1093/mnras/stv1230 Cite as: arXiv: 1505.00360 [astro-ph.GA] (or arXiv: 1505.00360v2 [astro-ph.GA] for this version)

Mean Spectral Energy Distributions and Bolometric Corrections for Luminous Quasars Coleman M. Krawczyk, Gordon T. Richards, Sajjan S. Mehta, Michael S. Vogeley, S. C. Gallagher, Karen M. Leighly, Nicholas P. Ross, Donald P. Schneider

(177) Authors explore the mid-infrared (mid-IR) through ultraviolet (UV) spectral energy distributions (SEDs) of 119,652 luminous broad-lined quasars with (e&eb) 0.064<z<5.46 using (e) mid-IR data from Spitzer and WISE, near-infrared data from (e) Two Micron All Sky Survey and UKIDSS, optical data from (e) Sloan Digital Sky Survey, and UV data from (e) Galaxy Evolution Explorer.

(178) The mean SED requires a bolometric correction (relative to 2500A) of BC=2.75+-0.40 using (e) the integrated light from 1um-2keV, and authors further explore (e&eb) the range of bolometric corrections exhibited by (e) individual objects.

(179) In addition, authors investigate the dependence of the mean SED on (eb) various parameters, particularly the UV luminosity for (e) quasars with 0.5<z<3 and the properties of the UV emission lines for (e) quasars with z>1.6; the latter is (=) a possible indicator of the strength of (e) the accretion disk wind, which is expected to be (=) SED dependent.

(180) Luminosity-dependent mean SEDs show that, relative to (e&eb) the high-luminosity SED, low-luminosity SEDs exhibit (eb) a harder (bluer) far-UV spectral slope, a redder optical continuum, and less hot dust.

(181) Mean SEDs constructed instead as (=) a function of UV emission line properties reveal (eb) changes that are consistent with (e&eb) known Principal Component Analysis (PCA) trends.

(182) A potentially important contribution to the bolometric correction is (=) the unseen extream-UV (EUV) continuum.

(183) Work suggests that lower-luminosity quasars and/or quasars with (e&eb) disk-dominated broad emission lines may require (e) an extra continuum component in (eb) the EUV that is not present (or much weaker) in (eb) high-luminosity quasars with (e&eb) strong accretion disk winds.

(184) As such, authors consider four possible models and explore the resulting (eb) bolometric corrections.

(185) Understanding these various SED-dependent effects will be important for (e) accurate determination of quasar accretion rates. Subjects: Cosmology and Nongalactic Astrophysics (astro-ph.CO) Journal reference: The Astrophysical Journal Supplement Series, 2013, Volume 206, Page 4 DOI:10.1088/0067-0049/206/1/4 Cite as: arXiv: 1304.5573 [astro-ph.CO] (or arXiv: 1304.5573v1 [astro-ph.CO] for this version)

Photometric Properties of Void Galaxies in the Sloan Digital Sky Survey DR7 Data Release Fiona Hoyle, Michael S. Vogeley, Danny Pan

(186) Using the sample presented in Pan: 2011, authors analyse the photometric properties of 88,794 void galaxies and compare them to (e&eb) galaxies in higher density environments with (e&eb) the same absolute magnitude distribution.

(187) In Pan et al. (2011), authors found a total of 1054 dynamically distinct voids in the SDSS with radius larger than 10h^-1 Mpc.

(188) The voids are underdense, with (e&eb) delta rho/rho < -0.9 in their centers.

(189) Here authors study the photometric properties of (e) these void galaxies.

(190) Authors look at the u - r colours as an indication of (e) star formation activity and (e&eb) the inverse concentration index as (=) an indication of galaxy type.

(191) They find that void galaxies are statistically bluer than (e&eb) galaxies found in higher density environments with (e&eb) the same magnitude distribution.

(192) Authors examine the colours of (e) the galaxies as (=) a function of magnitude, and authors fit each colour distribution with (e&eb) a double-Gaussian model for (e) the red and blue subpopulations.

(193) As we move from bright to (e&eb) dwarf galaxies, (eb) the population of (e) red galaxies steadily decreases and (e&eb) the fraction of blue galaxies increases in both voids and walls, however the fraction of blue galaxies in (eb) the voids is always higher and (e&eb) bluer than in the walls.

(194) Authors also split (e&eb) the void and wall galaxies into (e&eb) samples depending on galaxy type.

(195) Authors find that late type void galaxies are (=) bluer than (e) late type wall galaxies and the same holds for early galaxies.

(196) Authors also find that early type, dwarf void galaxies are (=) blue in colour.

(197) Authors also study the properties of (e) void galaxies as (=) a function of their distance from (e) the center of the void.

(198) Authors find very little variation in (eb) the properties, such as magnitude, colour and type, of void galaxies as (=) a function of their location in the void.

(199) The only exception is that the dwarf void galaxies may live closer to (e) the center.

(200) The centers of (e) voids have (e) very similar density contrast and hence all void galaxies live in (eb) very similar density environments (ABRIDGED) Subjects: Cosmology and Nongalactic Astrophysics (astro-ph.CO) DOI:10.1111/j.1365-2966.2012.21943.x Cite as: arXiv: 1205.1843 [astro-ph.CO] (or arXiv: 1205.1843v1 [astro-ph.CO] for this version)

Cosmic Voids in Sloan Digital Sky Survey Data Release 7 Danny C. Pan, Michael S. Vogeley, Fiona Hoyle, Yun-Young Choi, Changbom Park

(201) Authors study the distribution of (e&eb) cosmic voids and void galaxies using (e) Sloan Digital Sky Survey Data Release 7 (SDSS DR7).

(202) Using (e) the Void Finder algorithm as described by (e) Hoyle 2002, Authors identify 1054 statistically significant voids in (eb) the northern galactic hemisphere with radii > 10 h^{-1} Mpc.

(203) The filling factor of voids in the sample volume is (=) 62%.

(204) The largest void is just over 30 h^ {-1} Mpc in (eb) effective radius.

(205) The median effective radius is (=) 17 h^ {-1} Mpc.

(206) The voids are found to be (=) significantly underdense, with density contrast \delta < -0.85 at (eb) the edges of (e) the voids.

(207) The radial density profiles of these voids are similar to (e, eb, =) predictions of dynamically distinct under (e&eb) densities in gravitational theory.

(208) Authors find 8,046 galaxies brighter than M_r = -20.09 within the voids, accounting for (e) 7% of the galaxies

(209) Authors compare the results of Void Finder on SDSS DR7 to mock catalogs generated from (e) a SPH halo model simulation as well as other \Lambda -CDM simulations and (e&eb) find similar void fractions and (e&eb) void sizes in (eb) the data and simulations.

(210) This catalog is made publicly available at this http URL for download. Subjects: Cosmology and Nongalactic Astrophysics (astro-ph.CO); Astrophysics of Galaxies (astro-ph.GA) DOI:10.1111/j.1365-2966.2011.20197.x Cite as: arXiv: 1103.4156 [astro-ph.CO] (or arXiv:1103.4156v2 [astro-ph.CO] for this version)

Galaxy Clustering Topology in the Sloan Digital Sky Survey Main Galaxy Sample: a Test for Galaxy Formation Models Yun-Young Choi, Changbom Park, Juhan Kim, J. Richard Gott III, David H. Weinberg, Michael S. Vogeley, Sungsoo S. Kim

(211) Authors measure the topology of (e) the main galaxy distribution using (e) the Seventh Data Release of the Sloan Digital Sky Survey, examining the dependence of galaxy clustering topology on (e&eb) galaxy properties.

(212) The observational results are used to (e) test galaxy formation models.

(213) A volume-limited sample defined by $M_r<-20.19$ enables us (eb) to measure the genus curve with amplitude of G=378 at $6h^{-1}$Mpc smoothing scale, with (e&eb) 4.8\% uncertainty including (e) all systematics and (e&eb) cosmic variance.

(214) The clustering topology over the smoothing length interval from 6 to $10h^{-1}$Mpc reveals (eb) a mild scale-dependence for (e) the shift ($\Delta\nu$) and (e&eb) void abundance (AV) parameters of (e) the genus curve.

(215) Authors find substantial bias in (e&eb) the topology of galaxy clustering with respect to (e&eb) the predicted topology of (e) the matter distribution, which varies with (e&eb) luminosity, morphology, color, and the smoothing scale of the density field. Separate models are expatiated for each parameter

(216) The distribution of (e&eb) relatively brighter galaxies shows (eb) a greater prevalence of (e) isolated clusters and (e&eb) more percolated voids.

(217) Even though early (late)-type galaxies show (eb) topology similar to (e&eb) that of red (blue) galaxies, the morphology dependence of (e) topology is (=) not identical to (e) the color dependence.

(218) In particular, the void abundance parameter AV depends on (∝) morphology more strongly than (e) on color.

(219) Authors test five galaxy assignment schemes applied to (e&eb) cosmological N-body simulations of a ΛCDM universe to generate (eb) mock galaxies: the Halo-Galaxy one-to-one Correspondence model (e&eb) the Halo Occupation Distribution model, and (e&eb) three implementations of Semi-Analytic Models (SAMs).

(220) None of the models reproduces (eb) all aspects of the observed clustering topology; the deviations vary (e&eb) from one model to another but include (e) statistically significant discrepancies in (eb) the abundance of isolated voids or isolated clusters and (e&eb) the amplitude and overall shift of (e&eb) the genus curve. (Abridged) Subjects: Cosmology and Nongalactic Astrophysics (astro-ph.CO) DOI:10.1088/0067-0049/190/1/181 Cite as:arXiv:1005.0256 [astro-ph.CO]

On the Star Formation Properties of Void Galaxies Crystal M. Moorman, Jackeline Moreno, Amanda White, Michael S. Vogeley, Fiona Hoyle, Riccardo Giovanelli, Martha P. Haynes

(221) Authors measure the star formation properties of two large samples of galaxies from the SDSS in large-scale cosmic voids on time scales of 10 Myr and 100 Myr, using Hα emission line strengths and GALEX FUV fluxes, respectively.

(222) The first sample consists of 109,818 optically selected galaxies. We find that void galaxies in this sample have higher specific star formation rates (SSFRs; star formation rates per unit stellar mass) than similar stellar mass galaxies in denser regions.

(223) The second sample is a subset of the optically selected sample containing 8070 galaxies with reliable HI detections from ALFALFA. For the full HI detected sample, SSFRs do not vary systematically with large-scale environment.

(224) However, investigating only the HI detected dwarf galaxies reveals a trend towards higher SSFRs in voids.

(225) Furthermore, we estimate the star formation rate per unit HI mass (known as the star formation efficiency; SFE) of a galaxy, as a function of environment. For the overall HI detected population, we notice no environmental dependence.

(226) Limiting the sample to dwarf galaxies again reveals a trend towards higher SFEs in voids.

(227) These results suggest that void environments provide a nurturing environment for dwarf galaxy evolution allowing for higher specific star formation rates and efficiencies. Comments: submitted to ApJ 12-2015 Subjects: Astrophysics of Galaxies (astro-ph.GA) Cite as: arXiv: 1601.04092 [astro-ph.GA] (or arXiv: 1601.04092v1 [astro-ph.GA] for this version)

The Optical Luminosity Function of Void Galaxies in the SDSS and ALFALFA Surveys Crystal M. Moorman, Michael S. Vogeley, Fiona Hoyle, Danny C. Pan, Martha P. Haynes, Riccardo Giovanelli

(228) Authors measure the r-band galaxy luminosity function (LF) across environments over the redshift range $0<z<0.107$ using the SDSS. We divide our sample into galaxies residing in large scale voids (void galaxies) and those residing in denser regions (wall galaxies).

(229) The best fitting Schechter parameters for void galaxies are: $\log\Phi*=-3.40\pm0.03$ log(Mpc−3), $M*=-19.88\pm0.05$, and $\alpha=-1.20\pm0.02$. For wall galaxies, the best fitting parameters are: $\log\Phi*=-2.86\pm0.02$ log (Mpc−3), $M*=-20.80\pm0.03$, and $\alpha=-1.16\pm0.01$.

(230) Authors find a shift in the characteristic magnitude, M∗, towards fainter magnitudes for void galaxies and find no significant difference between the faint-end slopes of the void and wall galaxy LFs.

(231) Authors investigate how low surface brightness selections effects can affect the galaxy LF.

(232) To attempt to examine a sample of galaxies that is relatively free of surface brightness selection effects, we compute the optical galaxy LF of galaxies detected by the blind HI survey, ALFALFA.

(233) Authors find that the global LF of the ALFALFA sample is not well fit by a Schechter function, because of the presence of a wide dip in the LF around $M_r=-18$ and an upturn at fainter magnitudes ($\alpha\sim-1.47$). We compare the HI selected r-band LF to various LFs of optically selected populations to determine where the HI selected optical LF obtains its shape.

(234) Authors find that sample selection plays a large role in determining the shape of the LF. Subjects: Astrophysics of Galaxies (astro-ph.GA) Journal reference: The Astrophysical Journal, Volume 810, p.108, 3 September 2015 DOI: 10.1088/0004-637X/810/2/108 Cite as: arXiv: 1508.04199 [astro-ph.GA] (or arXiv: 1508.04199v1 [astro-ph.GA] for this version)

The HI Mass Function and Velocity Width Function of Void Galaxies in the Arecibo Legacy Fast ALFA Survey Crystal M. Moorman, Michael S. Vogeley, Fiona Hoyle, Danny C. Pan, Martha P. Haynes, Riccardo Giovanelli

(235) Authors measure the HI mass function (HIMF) and velocity width function (WF) across environments over a range of masses $7.2<\log(M_{HI}/M_\odot)<10.8$, and profile widths 1.3log(km/s)<log(W)<2.9log(km/s), using a catalog of ~7,300 HI-selected galaxies from the ALFALFA Survey, located in the region of sky where ALFALFA and SDSS (Data Release 7) North overlap.

(236) Authors divide our galaxy sample into those that reside in large-scale voids (void galaxies) and those that live in denser regions (wall galaxies). We find the void HIMF to be well fit by a Schechter function with normalization $\Phi*=(1.37\pm0.1)\times10^{-2}h^3Mpc^{-3}$, characteristic mass $\log(M*/M_\odot)+2\log h_{70}=9.86\pm0.02$, and low-mass-end slope $\alpha=-1.29\pm0.02$. Similarly, for wall galaxies, we find best-fitting parameters $\Phi*=(1.82\pm0.03)\times10^{-2}h^3Mpc^{-3}$, $\log(M*/M_\odot)+2\log h_{70}=10.00\pm0.01$, and $\alpha=-1.35\pm0.01$.

(237) Authors conclude that void galaxies typically have slightly lower HI masses than their non-void counterparts, which is in agreement with the dark matter halo mass function shift in voids assuming a simple relationship between DM mass and HI mass.

(238) Authors also find that the low-mass slope of the void HIMF is similar to that of the wall HIMF suggesting that there is either no excess of low-mass galaxies in voids or there is an abundance of intermediate HI mass galaxies. Authors fit a modified Schechter function to the ALFALFA void WF and determine its best-fitting parameters to be $\Phi_*=0.21\pm0.1h^3Mpc^{-3}$, $\log(W_*)=2.13\pm0.3$, $\alpha=0.52\pm0.5$ and high-width slope $\beta=1.3\pm0.4$.

(239) For wall galaxies, the WF parameters are: $\Phi_*=0.022\pm0.009h^3Mpc^{-3}$, $\log(W_*)=2.62\pm0.5$, $\alpha=-0.64\pm0.2$ and $\beta=3.58\pm1.5$.

(240) Because of large uncertainties on the void and wall width functions, we cannot conclude whether the WF is dependent on the environment. Subjects: Astrophysics of Galaxies (astro-ph.GA); Cosmology and Nongalactic Astrophysics (astro-ph.CO) Journal reference: Monthly Notices of the Royal Astronomical Society 2014, Volume 444, Issue 2: p.3559-3570 DOI: 10.1093/mnras/stu1674 Cite as: arXiv:1408.3392 [astro-ph.GA] (or arXiv:1408.3392v2 [astro-ph.GA] for this version)

GRAVITY DUAL FOR REGGEON FIELD THEORY AND NONLINEAR QUANTUM FINANCE YU NAKAYAMA

(241) Authors study scale invariant but not necessarily conformal invariant deformations of nonrelativistic conformal field theories from the dual gravity viewpoint.

(242) Authors present the corresponding metric that solves the Einstein equation coupled with a massive vector field. Authors find that, within the class of metric we study, when we assume the Galilean invariance, the scale invariant deformation always preserves the nonrelativistic conformal invariance.

(243) Authors discuss applications to scaling regime of Reggeon field theory and nonlinear quantum finance.

(244) These theories possess scale invariance but may or may not break the conformal invariance, depending on the underlying symmetry assumptions. Keywords: Nonrelativistic AdS/CFT; quantum finance; Reggeon field theory Read More: http://www.worldscientific.com/doi/abs/10.1142/S0217751X09047594

Simultaneous Interconnection and Damping Assignment Passivity-based Control of Mechanical Systems Using Generalized Forces Alejandro Donaire, Romeo Ortega, Jose Guadalupe Romero

(245) To extend the realm of application of the well known controller design technique of interconnection and (e&eb) damping assignment passivity-based control (IDA-PBC) of (e) mechanical systems two modifications to (e) the standard method are presented in this article.

(246) First, similarly to [1], it is proposed to avoid (e) the splitting of the control action into energy-shaping and damping injection terms, but instead to carry them out simultaneously.

(247) Second, motivated by [2], we propose to consider the inclusion of generalised forces, going beyond the gyroscopic ones used in standard IDA-PBC. It is shown that several new controllers for mechanical systems designed invoking other (less systematic procedures) that do not satisfy the conditions of standard IDA-PBC, actually belong to this new class of SIDA-PBC. Subjects: Optimization and Control (math.OC); Systems and Control (cs.SY) Cite as: arXiv: 1506.07679 [math.OC] (or arXiv: 1506.07679v1 [math.OC] for this version)

AdS/CFT correspondence from Wikipedia, the free encyclopedia (For references kindly see Wikipedia). Note that the model is applicable for the following exposition. Further expatiation of the parametrisiational

representation and concomitant mathematical embodiments are not given in the body fabric for restraints on space.

(248) In theoretical physics, the anti-de Sitter (e &eb)/conformal field theory correspondence, sometimes called Maldacena duality or gauge/gravity duality, is (=) a conjectured relationship between two kinds of physical theories.

(249) On one side are anti-de Sitter spaces (AdS) which are used in (eb) theories of quantum gravity, formulated in terms of (e&eb) string theory or M-theory.

(250) On the other side of the correspondence are (=) conformal field theories (CFT) which are (=) quantum field theories, including theories similar to the Yang–Mills theories that describe elementary particles.

(251) The duality represents (eb) a major advance in our understanding of (e) string theory and (e&eb) quantum gravity.[1]

(252) This is because it provides (eb) a non-perturbative formulation of (e) string theory with (e&eb)certain boundary conditions and because (e) it is the most successful realization of (e) the holographic principle, an idea in quantum gravity originally proposed by Gerard't Hooft and promoted by Leonard Susskind.

(253) It also provides a powerful toolkit for studying strongly coupled quantum field theories.[2] Much of the usefulness of the duality results from (e) the fact that it is a strong-weak duality: when the fields of the quantum field theory are strongly interacting, (eb)the ones in the gravitational theory are weakly interacting and thus more mathematically tractable.

(254) This fact has been used to study many aspects of nuclear and condensed matter physics by translating problems in those subjects into (e&eb) more mathematically tractable problems in string theory.

Black hole information paradox

(255) In 1975, Stephen Hawking published a calculation which suggested that black holes are not (e) completely black but emit a dim radiation due to(e) quantum effects near the event horizon.[36]

(256) At first, Hawking's result posed (eb) a problem for theorists because (e) it suggested that black holes destroy (e) information.

(257) More precisely, Hawking's calculation seemed to conflict with (e&eb) one of the basic postulates of quantum mechanics, which states that (eb) physical systems evolve in time according to the Schrödinger equation.

(258) This property is usually referred to as (=) unitarity of time evolution. The apparent contradiction between Hawking's calculation and (e&eb) the unitarity postulate of quantum mechanics came to be known as the black hole information paradox.[37]

(259) The AdS/CFT correspondence resolves (e) the black hole information paradox, at least to some extent, because it shows (eb) how a black hole can evolve (eb) in a manner consistent with quantum mechanics in some contexts.

(260) Indeed, one can consider black holes in (eb) the context of the AdS/CFT correspondence, and any such black hole corresponds to (e&eb) a configuration of particles on the boundary of (e) anti-de Sitter space.[38]

(261) These particles obey (eb) the usual rules of quantum mechanics and in particular evolve (eb) in a unitary fashion, so the black hole must also evolve (eb) in a unitary fashion, respecting (e&eb) the principles of quantum mechanics.[39]

(262) In 2005, Hawking announced that the paradox had been settled in favor of information conservation by (e0 the AdS/CFT correspondence, and he suggested a concrete mechanism by which black holes might preserve information.[40]

(263) The AdS/CFT correspondence was first proposed by Juan Maldacena in late 1997. Important aspects of the correspondence were elaborated in articles by Steven Gubser, Igor Klebanov, and Alexander Markovich Polyakov, and by Edward Witten. By 2015, Maldacena's article had over 10,000 citations, becoming the most highly cited article in the field of high energy physics.[3]

Background

Quantum gravity and strings

(264) Our current understanding of gravity is based on (e) Albert Einstein's general theory of relativity.[4] Formulated in 1915, general relativity explains gravity in terms of (e&eb) the geometry of space and time, or spacetime.

(265) It is formulated in the language of classical physics [5] developed by (e) physicists such as Isaac Newton and James Clerk Maxwell. The other nongravitational forces are explained in (eb) the framework of quantum mechanics.

(266) Developed in the first half of the twentieth century by a number of different physicists, quantum mechanics provides (eb) a radically different way of describing physical phenomena based on (e) probability.[6]

(267) Quantum gravity is the branch of physics that seeks to describe gravity using (e) the principles of quantum mechanics.

(268) Currently, the most popular approach to quantum gravity is (=) string theory,[7] which models elementary particles not as zero-dimensional points but as (=) one-dimensional objects called strings.

(269) In the AdS/CFT correspondence, one typically considers theories of quantum gravity derived from (e) string theory or its modern extension, M-theory.[8]

(270) In everyday life, there are three familiar dimensions of space (up/down, left/right, and forward/backward), and there is (=) one dimension of time.

(271) Thus, in the language of modern physics, one says that spacetime is (=) four-dimensional.[9]

(272) One peculiar feature of string theory and M-theory is that these theories require (e) extra dimensions of spacetime for their mathematical consistency: in string theory spacetime is (=) ten-dimensional, while in M-theory it (=) is eleven-dimensional.[10]

(273) The quantum gravity theories appearing in (eb) the AdS/CFT correspondence are typically obtained from (e) string and M-theory by a process known as compactification.

(274) This produces (eb) a theory in which spacetime has (e) effectively a lower number of (e) dimensions and the extra dimensions are (=) "curled up" into circles.[11]

(275) A standard analogy for compactification is to consider a multidimensional object such as a garden hose. If the hose is viewed from (e) a sufficient distance (eb) it appears to have (e) only one dimension, its length, but as one approaches (eb: distance) the hose, one discovers (eb) that it contains (e) a second dimension, its circumference. Thus, an ant crawling inside it would move (e&eb) in two dimensions.[12]

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SECTION ONE	

Quasinormal Modes Of Black Holes

INTRODUCTION—VARIABLES USED

Quasinormal modes of black holes and black branes Emanuele Berti, Vitor Cardoso, Andrei O. Starinets

(1) Quasinormal modes are (=) eigenmodes of dissipative systems.
(2) Perturbations of classical gravitational backgrounds involving (e&eb) black holes or branes naturally lead to (eb) quasinormal modes.
(3) The analysis and classification of the quasinormal spectra requires (e) solving non-Hermitian eigenvalue problems for (e) the associated linear differential equations.
(4) Within the recently developed gauge-gravity duality, these modes serve as (=) an important tool for determining (eb) the near-equilibrium properties of strongly coupled quantum field theories, in particular their transport coefficients, such as (=) viscosity, conductivity and diffusion constants.
(5) In astrophysics, the detection of quasinormal modes in (eb) gravitational wave experiments would allow (eb) precise measurements of the mass and spin of black holes as well as (=) new tests of general relativity.
(6) This review is meant as an introduction to the subject, with a focus on the recent developments in the field. Subjects: General Relativity and Quantum Cosmology (gr-qc); High Energy Astrophysical Phenomena (astro-ph.HE); High Energy Physics - Phenomenology (hep-ph); High Energy Physics - Theory (hep-th) DOI: 10.1088/0264-9381/26/16/163001 Cite as: arXiv:0905.2975 [gr-qc] (or arXiv:0905.2975v2 [gr-qc] for this version)

Stability of Gabor frames under small time Hamiltonian evolutions Maurice A. de Gosson, Karlheinz Gröchenig, and José Luis Romero

(7) Authors consider Hamiltonian deformations of (e) Gabor systems, where (e) the window evolves according to (e&eb) the action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow.
(8) Authors prove the stability of (e) the frame property for (e) small times and Hamiltonians consisting of (e) a quadratic polynomial plus a potential in the Sj\"ostrand class with (e&eb) bounded second order derivatives.
(9) This answers a question raised in [de Gosson, M. Symplectic and Hamiltonian Deformations of Gabor Frames. Appl. Comput. Harmon. Anal. Vol. 38 No.2, (2015) p.196--221.] Subjects: Mathematical Physics (math-ph); Classical Analysis and ODEs (math.CA) MSC classes: 34D20, 35Q41, 35S05, 42C15, 42C40 Cite as: arXiv: 1511.00121 [math-ph] (or arXiv: 1511.00121v1 [math-ph] for this version)

NOTATION

Module One

Quasinormal modes are (=) eigenmodes of dissipative systems

G_{13} : Category one of Quasinormal modes

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of eigenmodes of dissipative systems

T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two Perturbations of classical gravitational backgrounds involving (e&eb) black holes or branes naturally lead to (eb) quasinormal modes	
G_{16} : Category one of **Perturbations of classical gravitational backgrounds;** black holes or branes naturally lead to (eb) quasinormal modes G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of black holes or branes naturally lead to (eb) quasinormal modes; **Perturbations of classical gravitational backgrounds** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three Perturbations of classical gravitational backgrounds involving black holes or branes naturally lead to (eb) quasinormal modes	
G_{20} : Category one of Perturbations of classical gravitational backgrounds involving black holes or branes G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of quasinormal modes T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four The analysis and classification of the quasinormal spectra requires (e) solving non-Hermitian eigenvalue problems for (e) the associated linear differential equations	
G_{24} : Category one of solving non-Hermitian eigenvalue problems for (e) the associated linear differential equations G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of analysis and classification of the quasinormal spectra T_{25} : Category two of SAS	

T_{26} : Category three of SAS	
Module five The analysis and classification of the quasinormal spectra requires solving non-Hermitian eigenvalue problems for (e) the associated linear differential equations	
G_{28} : Category one of associated linear differential equations G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of analysis and classification of the quasinormal spectra requires solving non-Hermitian eigenvalue problems T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six these modes within the recently developed gauge-gravity duality serve as (=) an important tool for determining (eb) the near-equilibrium properties of strongly coupled quantum field theories, in particular their transport coefficients, such as (=) viscosity, conductivity and diffusion constants	
G_{32} : Category one of these modes within the recently developed gauge-gravity duality G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of important tool for determining (eb) the near-equilibrium properties of strongly coupled quantum field theories, in particular their transport coefficients, such as (=) viscosity, conductivity and diffusion constants T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven these modes within the recently developed gauge-gravity duality serve as an important tool for determining (eb) the near-equilibrium properties of strongly coupled quantum field theories, in particular their transport coefficients, such as (=) viscosity, conductivity and diffusion constants	
G_{36} : Category one of these modes within the recently developed gauge-gravity duality serve as an important tool G_{37} : Category two of SAS G_{38} : Category three of SAS	

T_{36} : Category one of near-equilibrium properties of strongly coupled quantum field theories, in particular their transport coefficients, such as (=) viscosity, conductivity and diffusion constants T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight these modes within the recently developed gauge-gravity duality serve as an important tool for determining the near-equilibrium properties of strongly coupled quantum field theories, in particular their transport coefficients, such as (=) **viscosity, conductivity and diffusion constants**	
G_{40} : Category one of these modes within the recently developed gauge-gravity duality serve as an important tool for determining the near-equilibrium properties of strongly coupled quantum field theories, in particular their transport coefficients; **viscosity, conductivity and diffusion constants** G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of **viscosity, conductivity and diffusion constants** ;these modes within the recently developed gauge-gravity duality serve as an important tool for determining the near-equilibrium properties of strongly coupled quantum field theories, in particular their transport coefficients T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine In astrophysics, the detection of quasinormal modes in (eb) gravitational wave experiments would allow (eb) precise measurements of the mass and spin of black holes as well as (=) new tests of general relativity.	
G_{44} : Category one of detection of quasinormal modes in gravitational wave experiments G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of precise measurements of the mass and spin of black holes as well as (=) new tests of general relativity T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$,	

$(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a_{13}')^{(1)}, (a_{14}')^{(1)}, (a_{15}')^{(1)}, (b_{13}')^{(1)}, (b_{14}')^{(1)}, (b_{15}')^{(1)}, (a_{16}')^{(2)}, (a_{17}')^{(2)}, (a_{18}')^{(2)}, (b_{16}')^{(2)}, (b_{17}')^{(2)}, (b_{18}')^{(2)}$ $, (a_{20}')^{(3)}, (a_{21}')^{(3)}, (a_{22}')^{(3)}, (b_{20}')^{(3)}, (b_{21}')^{(3)}, (b_{22}')^{(3)}$ $(a_{24}')^{(4)}, (a_{25}')^{(4)}, (a_{26}')^{(4)}, (b_{24}')^{(4)}, (b_{25}')^{(4)}, (b_{26}')^{(4)}, (b_{28}')^{(5)}, (b_{29}')^{(5)}, (b_{30}')^{(5)} (a_{28}')^{(5)}, (a_{29}')^{(5)}, (a_{30}')^{(5)}$, $(a_{32}')^{(6)}, (a_{33}')^{(6)}, (a_{34}')^{(6)}, (b_{32}')^{(6)}, (b_{33}')^{(6)}, (b_{34}')^{(6)}$ $(a_{36}')^{(7)}, (a_{37}')^{(7)}, (a_{38}')^{(7)}, (b_{36}')^{(7)}, (b_{37}')^{(7)}, (b_{38}')^{(7)}$, $(a_{40}')^{(8)}, (a_{41}')^{(8)}, (a_{42}')^{(8)}, (b_{40}')^{(8)}, (b_{41}')^{(8)}, (b_{42}')^{(8)}$, $(a_{44}')^{(9)}, (a_{45}')^{(9)}, (a_{46}')^{(9)}, (b_{44}')^{(9)}, (b_{45}')^{(9)}, (b_{46}')^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G, t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b_{14}')^{(1)} - (b_{14}'')^{(1)}(G, t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G, t) \right] T_{15}$	6
$+(a_{13}'')^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b_{13}'')^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}, t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17}, t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}, t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b_{16}')^{(2)} - (b_{16}'')^{(2)}\left((G_{19}), t \right) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b_{17}')^{(2)} - (b_{17}'')^{(2)}\left((G_{19}), t \right) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b_{18}')^{(2)} - (b_{18}'')^{(2)}\left((G_{19}), t \right) \right] T_{18}$	12
$+(a_{16}'')^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b_{16}'')^{(2)}\left((G_{19}), t \right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	

$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}, t)\right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}, t)\right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}, t)\right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}, t)\right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}, t)\right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}, t)\right] T_{22}$	18
$+(a''_{20})^{(3)}(T_{21}, t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23}, t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}, t)\right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}, t)\right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27}), t\right)\right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27}), t\right)\right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27}), t\right)\right] T_{26}$	24
$+(a''_{24})^{(4)}(T_{25}, t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)}\left((G_{27}), t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}, t)\right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}, t)\right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\left((G_{31}), t\right)\right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\left((G_{31}), t\right)\right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\left((G_{31}), t\right)\right] T_{30}$	30
$+(a''_{28})^{(5)}(T_{29}, t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}\left((G_{31}), t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33}, t)\right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33}, t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}), t\right)\right] T_{32}$	34

$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right]G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41},t)\right]G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*55*

$$\frac{dG_{14}}{dt}=(a_{14})^{(1)}G_{13}-\left[\begin{matrix}(a_{14}^{'})^{(1)}\boxed{+(a_{14}^{''})^{(1)}(T_{14},t)}\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)}\boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)}\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{14} \quad 56$$

$$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\left[\begin{matrix}(a_{15}^{'})^{(1)}\boxed{+(a_{15}^{''})^{(1)}(T_{14},t)}\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)}\boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)}\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{15} \quad 57$$

Where $\boxed{(a_{13}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{14}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{15}^{''})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\left[\begin{matrix}(b_{13}^{'})^{(1)}\boxed{-(b_{13}^{''})^{(1)}(G,t)}\boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)}\boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{36}^{''})^{(7,7,)}(G_{39},t)}\boxed{-(b_{40}^{''})^{(8,8)}(G_{43},t)}\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{13} \quad 58$$

$$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[\begin{matrix}(b_{14}^{'})^{(1)}\boxed{-(b_{14}^{''})^{(1)}(G,t)}\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}\boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{37}^{''})^{(7,7,)}(G_{39},t)}\boxed{-(b_{41}^{''})^{(8,8)}(G_{43},t)}\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{14} \quad 59$$

$$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[\begin{matrix}(b_{15}^{'})^{(1)}\boxed{-(b_{15}^{''})^{(1)}(G,t)}\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}\boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}\boxed{-(b_{42}^{''})^{(8,8)}(G_{43},t)}\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{15} \quad 60$$

Where $\boxed{-(b_{13}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for

category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16} \quad 61$$

$$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{17} \quad 62$$

$$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{18} \quad 63$$

Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[\begin{matrix}(b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\ \boxed{-(b''_{13})^{(1,1,)}(G,t)}\ \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{16}$	64
$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[\begin{matrix}(b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\ \boxed{-(b''_{14})^{(1,1,)}(G,t)}\ \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{17}$	65
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[\begin{matrix}(b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\ \boxed{-(b''_{15})^{(1,1,)}(G,t)}\ \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\left[\begin{matrix}(a'_{20})^{(3)}\boxed{+(a''_{20})^{(3)}(T_{21},t)}\ \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}\ \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}\ \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}\ \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}\ \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}\ \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}\end{matrix}\right]G_{20}$	67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21} \quad 68$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22} \quad 69$$

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \begin{bmatrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for*

category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$

are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$

are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$

are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$

are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$

are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28} \quad 79$$

$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \begin{bmatrix} (a_{29}')^{(5)} \boxed{+(a_{29}'')^{(5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \begin{bmatrix} (a_{30}')^{(5)} \boxed{+(a_{30}'')^{(5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
$Where$ $\boxed{+(a_{28}'')^{(5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5)}(T_{29},t)}$ $are\ first\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ And $\boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)}$ $are\ second\ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \begin{bmatrix} (b_{28}')^{(5)} \boxed{-(b_{28}'')^{(5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{32}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \begin{bmatrix} (b_{29}')^{(5)} \boxed{-(b_{29}'')^{(5)}(G_{31},t)} \boxed{-(b_{25}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{33}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1)}(G,t)} \boxed{-(b_{17}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{37}'')^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \begin{bmatrix} (b_{30}')^{(5)} \boxed{-(b_{30}'')^{(5)}(G_{31},t)} \boxed{-(b_{26}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{34}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,)}(G,t)} \boxed{-(b_{18}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}'')^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$	84
$where$ $\boxed{-(b_{28}'')^{(5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5)}(G_{31},t)}$ $are\ first\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b_{24}'')^{(4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,)}(G_{27},t)}$ $are\ second\ detrition\ coefficients$	

$for\ category$ 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category$ 1,2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$$ 85

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)}\boxed{+(a''_{33})^{(6)}(T_{33},t)}\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$$ 86

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)}\boxed{+(a''_{34})^{(6)}(T_{33},t)}\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$$ 87

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ $are\ first\ augmentation\ coefficients$ $for\ category$ 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ $are\ second\ augmentation$ $coefficients\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ $are\ third\ augmentation$ $coefficients\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$

seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$

Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34} \quad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 91

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$ 92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$ 93

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$ 94

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40}-\begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt}=$$

$$(b_{42})^{(8)}T_{41}-\begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt}=(a_{44})^{(9)}G_{45}-\begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13} \quad 96$$

$$\frac{dG_{45}}{dt}=(a_{45})^{(9)}G_{44}-\begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \le (p_i)^{(1)} \le (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \le \ (r_i)^{(1)} \le (b'_i)^{(1)} \le (\hat{B}_{13})^{(1)}$	97
$lim_{T_2 \to \infty} (a''_i)^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b''_i)^{(1)} (G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\lvert(a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\rvert \le (\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)}$, $(r_i)^{(1)}, i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i')^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i')^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0, \quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}$, $(r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t)\le(p_i)^{(2)}\le(\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t)\le (r_i)^{(2)}\le(b_i')^{(2)}\le(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}((G_{19}),t)= (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i=16,17,18$	106
They satisfy Lipschitz condition:	

$\lvert (a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert (b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert (G_{19})-(G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
<u>**Definition of**</u> $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)}+(a_i')^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i')^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(3)},\ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21},t)\leq(p_i)^{(3)}\leq(\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t)\leq\ (r_i)^{(3)}\leq(b_i')^{(3)}\leq(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}\ (T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}\ (G_{23},t)=\ (r_i)^{(3)}$ <u>**Definition of**</u> $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}}$ are positive constants and $\boxed{i=20,21,22}$	113

They satisfy Lipschitz condition: $\lvert(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21}-T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i'')^{(3)}(G_{23}',t)-(b_i'')^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23}-G_{23}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and $(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}}<1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[\ (a_i)^{(3)}+(a_i')^{(3)}+\ (\hat{A}_{20})^{(3)}+\ (\hat{P}_{20})^{(3)}\ (\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[\ (b_i)^{(3)}+(b_i')^{(3)}+\ (\hat{B}_{20})^{(3)}+\ (\hat{Q}_{20})^{(3)}\ (\hat{k}_{20})^{(3)}]<1$	116
Where we suppose	
$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)}>0, \quad i,j=24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t)\leq(p_i)^{(4)}\leq(\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}\big((G_{27}),t\big)\leq\ (r_i)^{(4)}\leq(b_i')^{(4)}\leq(\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}\big((G_{27}),t\big)=\ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i=24,25,26}$	118
They satisfy Lipschitz condition:	119

$\|(a_i^{''})^{(4)}(T_{25}^{'},t)-(a_i^{''})^{(4)}(T_{25},t)\|\leq(\hat{k}_{24})^{(4)}\|T_{25}-T_{25}^{'}\|e^{-(\hat{M}_{24})^{(4)}t}$ $\|(b_i^{''})^{(4)}((G_{27})^{'},t)-(b_i^{''})^{(4)}\big((G_{27}),t\big)\|<(\hat{k}_{24})^{(4)}\|\|(G_{27})-(G_{27})^{'}\|\|e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and$(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\big[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}\big]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
<u>Definition of</u> $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i^{'})^{(4)},(b_i)^{(4)},(b_i^{'})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)},i=24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (a_i)^{(4)}+(a_i^{'})^{(4)}+\ (\hat{A}_{24})^{(4)}+\ (\hat{P}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)}+(b_i^{'})^{(4)}+\ (\hat{B}_{24})^{(4)}+\ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i^{'})^{(5)},(a_i^{''})^{(5)},(b_i)^{(5)},(b_i^{'})^{(5)},(b_i^{''})^{(5)}>0,\quad i,j=28,29,30$ The functions $(a_i^{''})^{(5)},(b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(5)},\ \ (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t)\leq(p_i)^{(5)}\leq(\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}\big((G_{31}),t\big)\leq\ \ (r_i)^{(5)}\leq(b_i^{'})^{(5)}\leq(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i^{''})^{(5)}\ (T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}\ (G_{31},t)=\ \ (r_i)^{(5)}$ **<u>Definition of</u>** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ \ (r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123

They satisfy Lipschitz condition: $\|(a_i^{''})^{(5)}(T_{29}^{'},t)-(a_i^{''})^{(5)}(T_{29},t)\| \leq (\hat{k}_{28})^{(5)}\|T_{29}-T_{29}^{'}\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i^{''})^{(5)}((G_{31})^{'},t)-(b_i^{''})^{(5)}((G_{31}),t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31})-(G_{31})^{'}\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and $(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
<u>**Definition of**</u> $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i^{'})^{(5)},(b_i)^{(5)},(b_i^{'})^{(5)},(p_i)^{(5)},(r_i)^{(5)},i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)}+(a_i^{'})^{(5)}+(\hat{A}_{28})^{(5)}+(\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)}+(b_i^{'})^{(5)}+(\hat{B}_{28})^{(5)}+(\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i^{'})^{(6)},(a_i^{''})^{(6)},(b_i)^{(6)},(b_i^{'})^{(6)},(b_i^{''})^{(6)}>0, \quad i,j=32,33,34$ The functions $(a_i^{''})^{(6)},(b_i^{''})^{(6)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i^{''})^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i^{''})^{(6)}((G_{35}),t) \leq (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
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Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}((G_{35}), t)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>**Definition of**</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(A) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i, j = 36,37,38$ (B) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq \ (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
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Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\rvert < (\hat{k}_{36})^{(7)} \lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (E) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (F) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
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$(b_i'')^{(8)}((G_{43}),t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty} (a_i'')^{(8)}(T_{41},t) = (p_i)^{(8)}$	140
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Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t) - (a_i'')^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)},$ are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i')^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
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Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$$(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$$

$$(b_i^{''})^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$$

$$\lim_{T_2\to\infty} (a_i^{''})^{(9)}(T_{45},t) = (p_i)^{(9)}$$

$$\lim_{G\to\infty} (b_i^{''})^{(9)}(G_{47},t) = (r_i)^{(9)}$$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$$|(a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}^{'}|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}\big((G_{47}),t\big)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})^{'}||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $\big[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\big]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)} + (a_i^{'})^{(9)} + \ (\hat{A}_{44})^{(9)} + \ (\hat{P}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)} + (b_i^{'})^{(9)} + \ (\hat{B}_{44})^{(9)} + \ (\hat{Q}_{44})^{(9)}\ \ (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13}\right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$:	153

$G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{16})^{(2)}, T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a'_{20})^{(3)} + a''_{20})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \leq (\hat{P}_{24})^{(4)},\ T_i^0 \leq (\hat{Q}_{24})^{(4)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \leq (\hat{P}_{28})^{(5)},\ T_i^0 \leq (\hat{Q}_{28})^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}')^{(5)} + a_{28}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}')^{(5)} - (b_{28}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}')^{(5)} - (b_{29}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}')^{(5)} - (b_{30}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{32})^{(6)}, T_i^0 \leq (\hat{Q}_{32})^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}')^{(6)} - (b_{33}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}')^{(6)} - (b_{34}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\,\hat{P}_{36}\,)^{(7)} \,, T_i^0 \leq (\,\hat{Q}_{36}\,)^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{36}\,)^{(7)} e^{(\,\hat{M}_{36}\,)^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{36}\,)^{(7)} e^{(\,\hat{M}_{36}\,)^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)} \left(T_{37}\left(s_{(36)}\right), s_{(36)}\right) \right) G_{36}\left(s_{(36)}\right) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}\left(s_{(36)}\right) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} \left(T_{37}\left(s_{(36)}\right), s_{(36)}\right) \right) G_{37}\left(s_{(36)}\right) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} \left(T_{37}\left(s_{(36)}\right), s_{(36)}\right) \right) G_{38}\left(s_{(36)}\right) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} \left(G_{39}\left(s_{(36)}\right), s_{(36)}\right) \right) T_{36}\left(s_{(36)}\right) \right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}\left(s_{(36)}\right) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} \left(G_{39}\left(s_{(36)}\right), s_{(36)}\right) \right) T_{37}\left(s_{(36)}\right) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} \left(G_{39}\left(s_{(36)}\right), s_{(36)}\right) \right) T_{38}\left(s_{(36)}\right) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\,\hat{P}_{40}\,)^{(8)} \,, T_i^0 \leq (\,\hat{Q}_{40}\,)^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{40}\,)^{(8)} e^{(\,\hat{M}_{40}\,)^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{40}\,)^{(8)} e^{(\,\hat{M}_{40}\,)^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}\left(s_{(40)}\right) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} \left(T_{41}\left(s_{(40)}\right), s_{(40)}\right) \right) G_{40}\left(s_{(40)}\right) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}\left(s_{(40)}\right) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} \left(T_{41}\left(s_{(40)}\right), s_{(40)}\right) \right) G_{41}\left(s_{(40)}\right) \right] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$, $T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that	168

$(G_{13}(t)-G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)}+G_{14}^0\right)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)}+(\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)}\left(G_{17}^0+(\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1+(a_{16})^{(2)}t\right)G_{17}^0 + \frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t}-1\right)$	169
From which it follows that $(G_{16}(t)-G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)}+G_{17}^0\right)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)}+(\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)}\left(G_{21}^0+(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1+(a_{20})^{(3)}t\right)G_{21}^0 + \frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t}-1\right)$	171
From which it follows that $(G_{20}(t)-G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{P}_{20})^{(3)}+G_{21}^0\right)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)}+(\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for G_{21} , $G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)}\left(G_{25}^0+(\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right] ds_{(24)} =$ $\left(1+(a_{24})^{(4)}t\right)G_{25}^0 + \frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t}-1\right)$	173
From which it follows that $(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)}\left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}}\right)\right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1\right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0\right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0}\right)} + (\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)}\left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}}\right)\right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1\right)$	176
From which it follows that $(G_{32}(t) - G_{32}^0) e^{-(\hat{M}_{32})^{(6)} t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left[\left((\hat{P}_{32})^{(6)} + G_{33}^0\right) e^{\left(-\frac{(\hat{P}_{32})^{(6)} + G_{33}^0}{G_{33}^0}\right)} + (\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(a) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)}\left(G_{37}^0 + (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} s_{(36)}}\right)\right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)} t\right) G_{37}^0 + \frac{(a_{36})^{(7)} (\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left(e^{(\hat{M}_{36})^{(7)} t} - 1\right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0) e^{-(\hat{M}_{36})^{(7)} t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right) e^{\left(-\frac{(\hat{P}_{36})^{(7)} + G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)}\left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}}\right)\right] ds_{(40)} =$	180

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From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41}, $G_{42}, T_{40}, T_{41}, T_{42}$	181
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From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t}\leq\frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45}, $G_{46}, T_{44}, T_{45}, T_{46}$	
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Indeed if we denote **Definition of** $\widetilde{G_{19}},\widetilde{T_{19}}$: $\left(\widetilde{G_{19}},\widetilde{T_{19}}\right)=\mathcal{A}^{(2)}(G_{19},T_{19})$	195
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In the same way , one can obtain $G_{22} \leq \left((\widehat{M}_{20})^{(3)} \right)_3 = G_{22}^0 + 2(a_{22})^{(3)} \left((\widehat{M}_{20})^{(3)} \right)_2 / (a_{22}')^{(3)}$ If G_{21} or G_{22} is bounded, the same property follows for G_{20} , G_{22} and G_{20} , G_{21} respectively.	
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Indeed if we denote

Definition of $\widetilde{(G_{27})}, \widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})}, \widetilde{(T_{27})} \right) = \mathcal{A}^{(4)}((G_{27}),(T_{27}))$

It results

$$\left|\tilde{G}_{24}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{24})^{(4)} \left|G_{25}^{(1)} - G_{25}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \, ds_{(24)} +$$

$$\int_0^t \{(a'_{24})^{(4)} \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$(a''_{24})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right)\left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$G_{24}^{(2)} |(a''_{24})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right) - (a''_{24})^{(4)}\left(T_{25}^{(2)}, s_{(24)}\right)| \; e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}}\} ds_{(24)}$$

Where $s_{(24)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on Equations it follows

$$\left|(G_{27})^{(1)} - (G_{27})^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} t} \leq$$ 226

$$\frac{1}{(\widehat{M}_{24})^{(4)}} \left((a_{24})^{(4)} + (a'_{24})^{(4)} + (\widehat{A}_{24})^{(4)} + (\widehat{P}_{24})^{(4)} (\widehat{k}_{24})^{(4)} \right) d\left(\left((G_{27})^{(1)}, (T_{27})^{(1)}; \; (G_{27})^{(2)}, (T_{27})^{(2)} \right) \right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 16: The fact that we supposed $(a''_{24})^{(4)}$ and $(b''_{24})^{(4)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ *and* $(\widehat{Q}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ respectively of $\mathbb{R}_+$. 227

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$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(4)} - (a''_i)^{(4)}(T_{25}(s_{(24)}), s_{(24)})\} ds_{(24)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b'_i)^{(4)} t)} > 0 \quad \text{for } t > 0$$

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$$G_{25} \leq \left((\widehat{M}_{24})^{(4)}\right)_2 = G_{25}^0 + 2(a_{25})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_1 / (a'_{25})^{(4)}$$

In the same way , one can obtain $G_{26} \leq \left((\widehat{M}_{24})^{(4)} \right)_3 = G_{26}^0 + 2(a_{26})^{(4)} \left((\widehat{M}_{24})^{(4)} \right)_2 / (a'_{26})^{(4)}$ If G_{25} *or* G_{26} is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.	
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
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The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
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$$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + ((\widehat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[((\widehat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}|G_i^{(1)}(t) - G_i^{(2)}(t)|e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}|T_i^{(1)}(t) - T_i^{(2)}(t)|e^{-(\widehat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

<u>**Definition of**</u> $\widetilde{(G_{47})}, \widetilde{(T_{47})} : (\widetilde{(G_{47})}, \widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}),(T_{47}))$
It results

$$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} e^{(\widehat{M}_{44})^{(9)}s_{(44)}} ds_{(44)} +$$
$$\int_0^t \{(a'_{44})^{(9)}|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)})|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} e^{(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a''_{44})^{(9)}(T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\} ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval [0, t]

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}|e^{-(\widehat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(((G_{47})^{(1)},(T_{47})^{(1)}; (G_{47})^{(2)},(T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

<u>**Remark 41:**</u> The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on t*) and hypothesis can replaced by a usual Lipschitz condition.

<u>**Remark 42:**</u> There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)}-(a_i^{''})^{(9)}(T_{45}(s_{(44)}),s_{(44)})\}ds_{(44)}\right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}\left((G_{47})(t),t\right)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}\left((G_{47})(t),t\right) < \varepsilon_9, T_{44}\,(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}\left((G_{47})(t),t\right) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14},t) + (a_{14}^{''})^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G,t) - (b''_{14})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
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and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)},\ if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a'_{15})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}\right] + G_{15}^0 e^{-(a'_{15})^{(1)}t}\right)$	286

$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
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Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(\mathrm{T}_{17}, t) + (a_{17}'')^{(2)}(\mathrm{T}_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\big((G_{19}), t\big) - (b_{17}'')^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
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Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \ \boldsymbol{if} \ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if} \ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \ \boldsymbol{if} \ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if} \ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}, \ \boldsymbol{if} \ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})} \left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t} \right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq \right.$ $\left. \frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a_{18}')^{(2)})} [e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}] + G_{18}^0 e^{-(a_{18}')^{(2)}t} \right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b_{18}')^{(2)})} \left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t} \right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)} + (r_{16})^{(2)} + (R_2)^{(2)})} \left[e^{((R_1)^{(2)} + (r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t} \right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
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Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b'_{16})^{(2)}$ $(R_2)^{(2)} = (b'_{18})^{(2)} - (r_{18})^{(2)}$	318
<u>Behavior of the solutions</u> **<u>Theorem 3:</u>** If we denote and define **<u>Definition of</u>** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a'_{20})^{(3)} + (a'_{21})^{(3)} - (a''_{20})^{(3)}(T_{21}, t) + (a''_{21})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b'_{20})^{(3)} + (b'_{21})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) - (b''_{21})^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
<u>Definition of</u> $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
<u>Definition of</u> $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},\ \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},\ \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}$, ***if*** $(\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a'_{22})^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a'_{22})^{(3)}t}\right] + G_{22}^0 e^{-(a'_{22})^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b'_{22})^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b'_{22})^{(3)}t}\right] + T_{22}^0 e^{-(b'_{22})^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}((G_{27}), t) - (b''_{25})^{(4)}((G_{27}), t) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations	329

$(a_{25})^{(4)}\left(v^{(4)}\right)^2 + (\sigma_1)^{(4)}v^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0\,, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0\,, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(v^{(4)}\right)^2 + (\sigma_2)^{(4)}v^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}\,, (m_2)^{(4)}\,, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}\,, (m_2)^{(4)}\,, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}\,, \boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)},$ and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}\,, \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)},$ and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)})}\left[e^{((S_1)^{(4)} - (p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)} + (r_{24})^{(4)})t}}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)} + (r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)} - (b'_{26})^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b'_{26})^{(4)}t}\right] + T_{26}^0 e^{-(b'_{26})^{(4)}t} \leq T_{26}(t) \leq$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}')^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}')^{(4)}$ $(R_2)^{(4)}=(b_{26}')^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\le-(a_{28}')^{(5)}+(a_{29}')^{(5)}-(a_{28}'')^{(5)}(T_{29},t)+(a_{29}'')^{(5)}(T_{29},t)\le-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\le-(b_{28}')^{(5)}+(b_{29}')^{(5)}-(b_{28}'')^{(5)}\big((G_{31}),t\big)-(b_{29}'')^{(5)}\big((G_{31}),t\big)\le-(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar\nu_1)^{(5)},,(\bar\nu_2)^{(5)},(\bar u_1)^{(5)},(\bar u_2)^{(5)}$: By $(\bar\nu_1)^{(5)}>0,(\bar\nu_2)^{(5)}<0$ and respectively $(\bar u_1)^{(5)}>0,(\bar u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar\nu_1)^{(5)},\boldsymbol{if}\ (\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar\nu_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar\nu_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}$, ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}$, ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)} t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)} t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)} t}\right] + G_{30}^0 e^{-(S_2)^{(5)} t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b_{30}')^{(5)})}\left[e^{(R_1)^{(5)} t} - e^{-(b_{30}')^{(5)} t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)} t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)} t}\right] + T_{30}^0 e^{-(R_2)^{(5)} t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}((G_{35}), t) - (b''_{33})^{(6)}((G_{35}), t) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}$, $\boldsymbol{if}$ $(\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}$, $\boldsymbol{if}$ $(\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}$, $\boldsymbol{if}$ $(u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}$, $\boldsymbol{if}$ $(u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^0 e^{(R_1)^{(6)}t} \le T_{32}(t) \le T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \le T_{32}(t) \le \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \le T_{34}(t) \le$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \le -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \le -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \le -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \le -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)} t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)} t}$	365
$(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})} \left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)} t} \right] + G_{38}^0 e^{-(S_2)^{(7)} t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})} [e^{(S_1)^{(7)} t} - e^{-(a_{38}')^{(7)} t}] + G_{38}^0 e^{-(a_{38}')^{(7)} t})$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})} \left[e^{(R_1)^{(7)} t} - e^{-(b_{38}')^{(7)} t} \right] + T_{38}^0 e^{-(b_{38}')^{(7)} t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)} + (r_{36})^{(7)} + (R_2)^{(7)})} \left[e^{((R_1)^{(7)} + (r_{36})^{(7)})t} - e^{-(R_2)^{(7)} t} \right] + T_{38}^0 e^{-(R_2)^{(7)} t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)} (m_2)^{(7)} - (a_{36}')^{(7)}$	370

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$

$(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$

$(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$

Behavior of the solutions of equation 371

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$:

$(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying

$-(\sigma_2)^{(8)} \leq -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$

$-(\tau_2)^{(8)} \leq -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$

Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: 372

By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$
and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and

Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$:

By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the

roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$

and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$

Definition of $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:-

If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by

$(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)} < (\nu_1)^{(8)}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)},\ \boldsymbol{if}\ (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$,
and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a'_{42})^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a'_{42})^{(8)}t}\right] + G_{42}^0 e^{-(a'_{42})^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \leq -(a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} - (a_{44}^{''})^{(9)}(T_{45}, t) + (a_{45}^{''})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \leq -(b_{44}^{'})^{(9)} + (b_{45}^{'})^{(9)} - (b_{44}^{''})^{(9)}\big((G_{47}), t\big) - (b_{45}^{''})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if}\ (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if}\ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if}\ (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if}\ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if}\ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

($\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0e^{-(S_2)^{(9)}t}\leq G_{46}(t)\leq$ $\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t}-e^{-(a_{46}')^{(9)}t}]+G_{46}^0e^{-(a_{46}')^{(9)}t}$)	
$\boxed{T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}}T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq\frac{1}{(\mu_2)^{(9)}}T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b_{46}')^{(9)}t}\right]+T_{46}^0e^{-(b_{46}')^{(9)}t}\leq T_{46}(t)\leq$ $\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0e^{-(R_2)^{(9)}t}$	
Definition of $(S_1)^{(9)},(S_2)^{(9)},(R_1)^{(9)},(R_2)^{(9)}$:- Where $(S_1)^{(9)}=(a_{44})^{(9)}(m_2)^{(9)}-(a_{44}')^{(9)}$ $(S_2)^{(9)}=(a_{46})^{(9)}-(p_{46})^{(9)}$ $(R_1)^{(9)}=(b_{44})^{(9)}(\mu_2)^{(9)}-(b_{44}')^{(9)}$ $(R_2)^{(9)}=(b_{46}')^{(9)}-(r_{46})^{(9)}$	

Proof : From global equations we obtain 383

$$\frac{dv^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14}, t)\right) - (a_{14}^{''})^{(1)}(T_{14}, t)v^{(1)} - (a_{14})^{(1)}v^{(1)}$$

Definition of $v^{(1)}$:- $\boxed{v^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_2)^{(1)}v^{(1)} - (a_{13})^{(1)}\right) \leq \frac{dv^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_1)^{(1)}v^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{v}_1)^{(1)}, (v_0)^{(1)}$:-

For $0 < \boxed{(v_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (v_1)^{(1)} < (\bar{v}_1)^{(1)}$

$$v^{(1)}(t) \geq \frac{(v_1)^{(1)} + (C)^{(1)}(v_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((v_1)^{(1)} - (v_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((v_1)^{(1)} - (v_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(v_1)^{(1)} - (v_0)^{(1)}}{(v_0)^{(1)} - (v_2)^{(1)}}}$$

it follows $(v_0)^{(1)} \leq v^{(1)}(t) \leq (v_1)^{(1)}$

In the same manner , we get 384

$$v^{(1)}(t) \leq \frac{(\bar{v}_1)^{(1)} + (\bar{C})^{(1)}(\bar{v}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{v}_1)^{(1)} - (\bar{v}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{v}_1)^{(1)} - (\bar{v}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{v}_1)^{(1)} - (v_0)^{(1)}}{(v_0)^{(1)} - (\bar{v}_2)^{(1)}}}$$

From which we deduce $(v_0)^{(1)} \leq v^{(1)}(t) \leq (\bar{v}_1)^{(1)}$

If $0 < (v_1)^{(1)} < (v_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{v}_1)^{(1)}$ we find like in the previous case, 385

$$(v_1)^{(1)} \leq \frac{(v_1)^{(1)} + (C)^{(1)}(v_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((v_1)^{(1)} - (v_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((v_1)^{(1)} - (v_2)^{(1)}\right)t\right]}} \leq v^{(1)}(t) \leq$$

$$\frac{(\bar{v}_1)^{(1)} + (\bar{C})^{(1)}(\bar{v}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{v}_1)^{(1)} - (\bar{v}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{v}_1)^{(1)} - (\bar{v}_2)^{(1)}\right)t\right]}} \leq (\bar{v}_1)^{(1)}$$

If $0 < (v_1)^{(1)} \leq (\bar{v}_1)^{(1)} \leq \boxed{(v_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(v_1)^{(1)} \leq v^{(1)}(t) \leq \frac{(\bar{v}_1)^{(1)} + (\bar{C})^{(1)}(\bar{v}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{v}_1)^{(1)} - (\bar{v}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{v}_1)^{(1)} - (\bar{v}_2)^{(1)}\right)t\right]}} \leq (v_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get 391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)} G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)} T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
Proof : From global equations we obtain	398

$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}')^{(3)} - (a_{21}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right) - (a_{21}'')^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:-	403

$(m_2)^{(3)} \leq \ \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq \ u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{24}'')^{(4)} = (a_{25}'')^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b_{24}'')^{(4)} = (b_{25}'')^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}')^{(5)} - (a_{29}')^{(5)} + (a_{28}'')^{(5)}(T_{29}, t)\right) - (a_{29}'')^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$ if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>**Proof**</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ <u>**Definition of**</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains <u>**Definition of**</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \le \frac{d\nu^{(8)}}{dt} \le -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \ge \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \le \nu^{(8)}(t) \le (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \le \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \le \nu^{(8)}(t) \le (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \le \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \le \nu^{(8)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \le (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \le (\bar{\nu}_1)^{(8)} \le \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \le \nu^{(8)}(t) \le \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \le (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$**, and definition of** $(u_0)^{(8)}$.

Proof : From 99,20,44,22,23,44 we obtain 424A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}'')^{(9)} = (a_{45}'')^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}'')^{(9)} = (b_{45}'')^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i'')^{(1)} and\ (b_i'')^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}')^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}')^{(1)}(r_{14})^{(1)} - (b_{14}')^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

$with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25})\right]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27}))\,]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}((G_{27}))\,]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27}))\,]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (a) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) +$	486

$(a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right] + (b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right] + (b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23})=(b_{20}')^{(3)}(b_{21}')^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23})+(b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right]+(b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27})=(b_{24}')^{(4)}(b_{25}')^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27})+(b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right]+(b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31})=(b_{28}')^{(5)}(b_{29}')^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31})+(b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right]+(b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35})=(b_{32}')^{(6)}(b_{33}')^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35})+(b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right]+(b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*})=0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39})=(b_{36}')^{(7)}(b_{37}')^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39})+(b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right]+(b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*})=0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43})=(b'_{40})^{(8)}(b'_{41})^{(8)}-(b_{40})^{(8)}(b_{41})^{(8)}-$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43})+(b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right]+(b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43})=0$ Where in $(G_{43})(G_{40},G_{41},G_{42}),G_{40},G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*)=0$	
By the same argument, the equations 92,93 admit solutions G_{44},G_{45} if $\varphi(G_{47})=(b'_{44})^{(9)}(b'_{45})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}-$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47})+(b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right]+(b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47})=0$ Where in $(G_{47})(G_{44},G_{45},G_{46}),G_{44},G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G^*_{45} such that $\varphi((G_{47})^*)=0$	
Finally we obtain the unique solution G^*_{14} given by $\varphi(G^*)=0$, T^*_{14} given by $f(T^*_{14})=0$ and $G^*_{13}=\frac{(a_{13})^{(1)}G^*_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G^*_{15}=\frac{(a_{15})^{(1)}G^*_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$ $T^*_{13}=\frac{(b_{13})^{(1)}T^*_{14}}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T^*_{15}=\frac{(b_{15})^{(1)}T^*_{14}}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G^*_{17} given by $\varphi((G_{19})^*)=0$, T^*_{17} given by $f(T^*_{17})=0$ and	512
$G^*_{16}=\frac{(a_{16})^{(2)}G^*_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G^*_{18}=\frac{(a_{18})^{(2)}G^*_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	513
$T^*_{16}=\frac{(b_{16})^{(2)}T^*_{17}}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T^*_{18}=\frac{(b_{18})^{(2)}T^*_{17}}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G^*_{21} given by $\varphi((G_{23})^*)=0$, T^*_{21} given by $f(T^*_{21})=0$ and $G^*_{20}=\frac{(a_{20})^{(3)}G^*_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G^*_{22}=\frac{(a_{22})^{(3)}G^*_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$ $T^*_{20}=\frac{(b_{20})^{(3)}T^*_{21}}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T^*_{22}=\frac{(b_{22})^{(3)}T^*_{21}}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^{*} given by $\varphi(G_{27}) = 0$, T_{25}^{*} given by $f(T_{25}^{*}) = 0$ and $G_{24}^{*} = \frac{(a_{24})^{(4)} G_{25}^{*}}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26}^{*} = \frac{(a_{26})^{(4)} G_{25}^{*}}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^{*})]}$	516
$T_{24}^{*} = \frac{(b_{24})^{(4)} T_{25}^{*}}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^{*})]}$, $T_{26}^{*} = \frac{(b_{26})^{(4)} T_{25}^{*}}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^{*} given by $\varphi((G_{31})^{*}) = 0$, T_{29}^{*} given by $f(T_{29}^{*}) = 0$ and $G_{28}^{*} = \frac{(a_{28})^{(5)} G_{29}^{*}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*} = \frac{(a_{30})^{(5)} G_{29}^{*}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$	518
$T_{28}^{*} = \frac{(b_{28})^{(5)} T_{29}^{*}}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*} = \frac{(b_{30})^{(5)} T_{29}^{*}}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*}) = 0$, T_{33}^{*} given by $f(T_{33}^{*}) = 0$ and $G_{32}^{*} = \frac{(a_{32})^{(6)} G_{33}^{*}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*} = \frac{(a_{34})^{(6)} G_{33}^{*}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*} = \frac{(b_{32})^{(6)} T_{33}^{*}}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^{*})]}$, $T_{34}^{*} = \frac{(b_{34})^{(6)} T_{33}^{*}}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*}) = 0$, T_{37}^{*} given by $f(T_{37}^{*}) = 0$ and $G_{36}^{*} = \frac{(a_{36})^{(7)} G_{37}^{*}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}^{*} = \frac{(a_{38})^{(7)} G_{37}^{*}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$ $T_{36}^{*} = \frac{(b_{36})^{(7)} T_{37}^{*}}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^{*})]}$, $T_{38}^{*} = \frac{(b_{38})^{(7)} T_{37}^{*}}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*}) = 0$, T_{41}^{*} given by $f(T_{41}^{*}) = 0$ and $G_{40}^{*} = \frac{(a_{40})^{(8)} G_{41}^{*}}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42}^{*} = \frac{(a_{42})^{(8)} G_{41}^{*}}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^{*})]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -((a_{13}^{'})^{(1)} + (p_{13})^{(1)})\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -((a_{14}^{'})^{(1)} + (p_{14})^{(1)})\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -((a_{15}^{'})^{(1)} + (p_{15})^{(1)})\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -((b_{13}^{'})^{(1)} - (r_{13})^{(1)})\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(13)(j)} T_{13}^* \mathbb{G}_j)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -((b_{14}^{'})^{(1)} - (r_{14})^{(1)})\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}(s_{(14)(j)} T_{14}^* \mathbb{G}_j)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -((b_{15}^{'})^{(1)} - (r_{15})^{(1)})\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(15)(j)} T_{15}^* \mathbb{G}_j)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_{j}\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_{j}\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_{j}\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_{j}\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_{j}\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}((G_{31})^{*}) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt}=-\left((a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\mathbb{G}_{28}+(a_{28})^{(5)}\mathbb{G}_{29}-(q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt}=-\left((a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)\mathbb{G}_{29}+(a_{29})^{(5)}\mathbb{G}_{28}-(q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt}=-\left((a_{30}^{'})^{(5)}+(p_{30})^{(5)}\right)\mathbb{G}_{30}+(a_{30})^{(5)}\mathbb{G}_{29}-(q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt}=-\left((b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)\mathbb{T}_{28}+(b_{28})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_{j}\right)$	560
$\frac{d\mathbb{T}_{29}}{dt}=-\left((b_{29}^{'})^{(5)}-(r_{29})^{(5)}\right)\mathbb{T}_{29}+(b_{29})^{(5)}\mathbb{T}_{28}+\sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_{j}\right)$	561
$\frac{d\mathbb{T}_{30}}{dt}=-\left((b_{30}^{'})^{(5)}-(r_{30})^{(5)}\right)\mathbb{T}_{30}+(b_{30})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_{j}\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad ,T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*})=(q_{33})^{(6)} \quad , \frac{\partial(b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^{*}\,)=s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt}=-\left((a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\mathbb{G}_{32}+(a_{32})^{(6)}\mathbb{G}_{33}-(q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt}=-\left((a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)\mathbb{G}_{33}+(a_{33})^{(6)}\mathbb{G}_{32}-(q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt}=-\left((a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)\mathbb{G}_{34}+(a_{34})^{(6)}\mathbb{G}_{33}-(q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt}=-\left((b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)\mathbb{T}_{32}+(b_{32})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_{j}\right)$	568
$\frac{d\mathbb{T}_{33}}{dt}=-\left((b_{33}^{'})^{(6)}-(r_{33})^{(6)}\right)\mathbb{T}_{33}+(b_{33})^{(6)}\mathbb{T}_{32}+\sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_{j}\right)$	569
$\frac{d\mathbb{T}_{34}}{dt}=-\left((b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\mathbb{T}_{34}+(b_{34})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_{j}\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \;, \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \;, \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*} + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^2 + \left((b'_{13})^{(1)} + (b'_{14})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$

$+((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}) \left((a_{15})^{(1)}(q_{14})^{(1)}G^*_{14} + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G^*_{13}\right)$

$\left(((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)})s_{(14),(15)}T^*_{14} + (b_{14})^{(1)}s_{(13),(15)}T^*_{13}\right)\} = 0$

$+$

$((\lambda)^{(2)} + (b'_{18})^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a'_{18})^{(2)} + (p_{18})^{(2)})$

$\left[\left(((\lambda)^{(2)} + (a'_{16})^{(2)} + (p_{16})^{(2)})(q_{17})^{(2)}\mathrm{G}^*_{17} + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}^*_{16}\right)\right]$

$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)})s_{(17),(17)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}^*_{17}\right)$

$+\left(((\lambda)^{(2)} + (a'_{17})^{(2)} + (p_{17})^{(2)})(q_{16})^{(2)}\mathrm{G}^*_{16} + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}^*_{17}\right)$

$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)})s_{(17),(16)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}^*_{16}\right)$

$\left(\left((\lambda)^{(2)}\right)^2 + \left((a'_{16})^{(2)} + (a'_{17})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^2 + \left((b'_{16})^{(2)} + (b'_{17})^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a'_{16})^{(2)} + (a'_{17})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right) (q_{18})^{(2)}\mathrm{G}_{18}$

$+((\lambda)^{(2)} + (a'_{16})^{(2)} + (p_{16})^{(2)}) \left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}^*_{17} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}^*_{16}\right)$

$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)})s_{(17),(18)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}^*_{16}\right)\} = 0$

$+$

$((\lambda)^{(3)} + (b'_{22})^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a'_{22})^{(3)} + (p_{22})^{(3)})$

$\left[\left(((\lambda)^{(3)} + (a'_{20})^{(3)} + (p_{20})^{(3)})(q_{21})^{(3)}G^*_{21} + (a_{21})^{(3)}(q_{20})^{(3)}G^*_{20}\right)\right]$

$\left(((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)})s_{(21),(21)}T^*_{21} + (b_{21})^{(3)}s_{(20),(21)}T^*_{21}\right)$

$+\left(((\lambda)^{(3)} + (a'_{21})^{(3)} + (p_{21})^{(3)})(q_{20})^{(3)}G^*_{20} + (a_{20})^{(3)}(q_{21})^{(1)}G^*_{21}\right)$

$\left(((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)})s_{(21),(20)}T^*_{21} + (b_{21})^{(3)}s_{(20),(20)}T^*_{20}\right)$

$\left(\left((\lambda)^{(3)}\right)^2+\left((a'_{20})^{(3)}+(a'_{21})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2+\left((b'_{20})^{(3)}+(b'_{21})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2+\left((a'_{20})^{(3)}+(a'_{21})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)}+(a'_{20})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G^*_{21}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G^*_{20}\right)$ $\left(\left((\lambda)^{(3)}+(b'_{20})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T^*_{21}+(b_{21})^{(3)}s_{(20),(22)}T^*_{20}\right)\}=0$ +	
$\left((\lambda)^{(4)}+(b'_{26})^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a'_{26})^{(4)}+(p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)}+(a'_{24})^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G^*_{25}+(a_{25})^{(4)}(q_{24})^{(4)}G^*_{24}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T^*_{25}+(b_{25})^{(4)}s_{(24),(25)}T^*_{25}\right)$ $+\left(\left((\lambda)^{(4)}+(a'_{25})^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G^*_{24}+(a_{24})^{(4)}(q_{25})^{(4)}G^*_{25}\right)$ $\left(\left((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T^*_{25}+(b_{25})^{(4)}s_{(24),(24)}T^*_{24}\right)$ $\left(\left((\lambda)^{(4)}\right)^2+\left((a'_{24})^{(4)}+(a'_{25})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2+\left((b'_{24})^{(4)}+(b'_{25})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2+\left((a'_{24})^{(4)}+(a'_{25})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)}+(a'_{24})^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G^*_{25}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G^*_{24}\right)$ $\left(\left((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T^*_{25}+(b_{25})^{(4)}s_{(24),(26)}T^*_{24}\right)\}=0$ +	
$\left((\lambda)^{(5)}+(b'_{30})^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a'_{30})^{(5)}+(p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)}+(a'_{28})^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G^*_{29}+(a_{29})^{(5)}(q_{28})^{(5)}G^*_{28}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T^*_{29}+(b_{29})^{(5)}s_{(28),(29)}T^*_{29}\right)$ $+\left(\left((\lambda)^{(5)}+(a'_{29})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G^*_{28}+(a_{28})^{(5)}(q_{29})^{(5)}G^*_{29}\right)$ $\left(\left((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T^*_{29}+(b_{29})^{(5)}s_{(28),(28)}T^*_{28}\right)$	

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right) (q_{30})^{(5)} G_{30}$$

$$+((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)}) \left((a_{30})^{(5)}(q_{29})^{(5)} G_{29}^{*} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)} G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right) s_{(29),(30)} T_{29}^{*} + (b_{29})^{(5)} s_{(28),(30)} T_{28}^{*}\right)\} = 0$$

+

$$((\lambda)^{(6)} + (b_{34}^{'})^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a_{34}^{'})^{(6)} + (p_{34})^{(6)})$$

$$\left[\left(\left((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)(q_{33})^{(6)} G_{33}^{*} + (a_{33})^{(6)}(q_{32})^{(6)} G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(33)} T_{33}^{*} + (b_{33})^{(6)} s_{(32),(33)} T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)} + (a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)(q_{32})^{(6)} G_{32}^{*} + (a_{32})^{(6)}(q_{33})^{(6)} G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(32)} T_{33}^{*} + (b_{33})^{(6)} s_{(32),(32)} T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((b_{32}^{'})^{(6)} + (b_{33}^{'})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right) (q_{34})^{(6)} G_{34}$$

$$+((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)}) \left((a_{34})^{(6)}(q_{33})^{(6)} G_{33}^{*} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)} G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(34)} T_{33}^{*} + (b_{33})^{(6)} s_{(32),(34)} T_{32}^{*}\right)\} = 0$$

+

$$((\lambda)^{(7)} + (b_{38}^{'})^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a_{38}^{'})^{(7)} + (p_{38})^{(7)})$$

$$\left[\left(\left((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)(q_{37})^{(7)} G_{37}^{*} + (a_{37})^{(7)}(q_{36})^{(7)} G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(37)} T_{37}^{*} + (b_{37})^{(7)} s_{(36),(37)} T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)} + (a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)(q_{36})^{(7)} G_{36}^{*} + (a_{36})^{(7)}(q_{37})^{(7)} G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(36)} T_{37}^{*} + (b_{37})^{(7)} s_{(36),(36)} T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}')^{(7)} + (a_{37}')^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}')^{(7)} + (b_{37}')^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}')^{(7)} + (a_{37}')^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right) (q_{38})^{(7)} G_{38}$$

$$+((\lambda)^{(7)} + (a_{36}')^{(7)} + (p_{36})^{(7)}) \left((a_{38})^{(7)}(q_{37})^{(7)} G_{37}^* + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)} G_{36}^*\right)$$

$$\left(((\lambda)^{(7)} + (b_{36}')^{(7)} - (r_{36})^{(7)}) s_{(37),(38)} T_{37}^* + (b_{37})^{(7)} s_{(36),(38)} T_{36}^*\right)\} = 0$$

$+$

$$((\lambda)^{(8)} + (b_{42}')^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a_{42}')^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a_{40}')^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)} G_{41}^* + (a_{41})^{(8)}(q_{40})^{(8)} G_{40}^*\right)\right]$$

$$\left(((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}) s_{(41),(41)} T_{41}^* + (b_{41})^{(8)} s_{(40),(41)} T_{41}^*\right)$$

$$+\left(((\lambda)^{(8)} + (a_{41}')^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)} G_{40}^* + (a_{40})^{(8)}(q_{41})^{(8)} G_{41}^*\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}) s_{(41),(40)} T_{41}^* + (b_{41})^{(8)} s_{(40),(40)} T_{40}^*\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}')^{(8)} + (a_{41}')^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}')^{(8)} + (b_{41}')^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}')^{(8)} + (a_{41}')^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right) (q_{42})^{(8)} G_{42}$$

$$+((\lambda)^{(8)} + (a_{40}')^{(8)} + (p_{40})^{(8)}) \left((a_{42})^{(8)}(q_{41})^{(8)} G_{41}^* + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)} G_{40}^*\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}) s_{(41),(42)} T_{41}^* + (b_{41})^{(8)} s_{(40),(42)} T_{40}^*\right)\} = 0$$

$+$

$$((\lambda)^{(9)} + (b_{46}')^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a_{46}')^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a_{44}')^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)} G_{45}^* + (a_{45})^{(9)}(q_{44})^{(9)} G_{44}^*\right)\right]$$

$$\left(((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)}) s_{(45),(45)} T_{45}^* + (b_{45})^{(9)} s_{(44),(45)} T_{45}^*\right)$$

$$+\left(((\lambda)^{(9)} + (a_{45}')^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)} G_{44}^* + (a_{44})^{(9)}(q_{45})^{(9)} G_{45}^*\right)$$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$ $\left(\left((\lambda)^{(9)}\right)^2+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$ $\left(\left((\lambda)^{(9)}\right)^2+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$ $+\left(\left((\lambda)^{(9)}\right)^2+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$ $+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$ $\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$ **And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.**	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**	

SECTION TWO

Stability Of Gabor Frames Under Small Time Hamiltonian Evolutions

INTRODUCTION—VARIABLES USED

Stability of Gabor frames under small time Hamiltonian evolutions Maurice A. de Gosson, Karlheinz Gröchenig, and José Luis Romero

(1) Authors consider Hamiltonian deformations of (e) Gabor systems, where (e) the window evolves according to (e&eb) the action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow.
(2) Authors prove the stability of (e) the frame property for (e) small times and Hamiltonians consisting of (e) a quadratic polynomial plus a potential in the Sj\"ostrand class with (e&eb) bounded second order derivatives.
(3) This answers a question raised in [de Gosson, M. Symplectic and Hamiltonian Deformations of Gabor Frames. Appl. Comput. Harmon. Anal. Vol. 38 No.2, (2015) p.196--221.] Subjects: Mathematical Physics (math-ph); Classical Analysis and ODEs (math.CA) MSC classes: 34D20, 35Q41, 35S05, 42C15, 42C40 Cite as: arXiv: 1511.00121 [math-ph] (or arXiv: 1511.00121v1 [math-ph] for this version)

Completeness of Gabor systems Karlheinz Gröchenig, Antti Haimi, José Luis Romero

(1) Authors investigate the completeness of Gabor systems with respect to (e&eb) several classes of window functions on (eb) rational lattices.
(2) main results show that the time-frequency shifts of (e) every finite linear combination of Hermite functions with respect to (e&eb) a rational lattice are complete in L2(R), thus generalizing (e&eb) a remark of von Neumann (and proved by Bargmann, Perelomov et al.).
(3) An analogous result is proven for (e) functions that factor into (e&eb) certain rational functions and the Gaussian.
(4) The results are also interesting from (e) a conceptual point of view since they show a vast difference between the completeness and (e&eb) the frame property of a Gabor system. In the terminology of physics we prove new results about the completeness of coherent state subsystems. Subjects: Mathematical Physics (math-ph) MSC classes: 42C30, 42C15, 81R30 Cite as: arXiv: 1507.02124 [math-ph] (or arXiv: 1507.02124v3 [math-ph] for this version)

NOTATION

Module One

Authors consider Hamiltonian deformations of (e) Gabor systems, where (e) the window evolves according to (e&eb) the action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{13} : Category one of Gabor systems, where (e) the window evolves according to (e&eb) the action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of Hamiltonian deformations

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Authors consider Hamiltonian deformations of Gabor systems, where (e) the window evolves according to (e&eb) the action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{16} : Category one of window evolves according to (e&eb) the action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of Hamiltonian deformations of Gabor systems

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

Authors consider Hamiltonian deformations of Gabor systems, where the window evolves according to (e&eb) the action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{20} : Category one of **Hamiltonian deformations of Gabor systems, where the window evolves;** action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow; **Hamiltonian deformations of Gabor systems, where the window evolves**

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

Authors consider Hamiltonian deformations of Gabor systems, where the window evolves according to the action of a Schr\"odinger propagator and (e&eb) the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{24} : Category one of **Hamiltonian deformations of Gabor systems, where the window evolves according to the action of a Schr\"odinger propagator;** phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow; **Hamiltonian deformations of Gabor systems, where the window evolves according to the action of a Schr\"odinger propagator**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

Authors consider Hamiltonian deformations of Gabor systems, where the window evolves according to the action of a Schr\"odinger propagator and the phase-space nodes evolve according to (e&eb) the corresponding Hamiltonian flow

G_{28} : Category one of **Hamiltonian deformations of Gabor systems, where the window evolves according to the action of a Schr\"odinger propagator and the phase-space nodes evolve;** corresponding Hamiltonian flow

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of corresponding Hamiltonian flow **; Hamiltonian deformations of Gabor systems, where the window evolves according to the action of a Schr\"odinger propagator and the phase-space nodes evolve**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

Authors prove the stability of the frame property for (e) small times and Hamiltonians consisting of (e) a quadratic polynomial plus a potential in the Sj\"ostrand class with (e&eb) bounded second order derivatives

G_{32} : Category one of small times and Hamiltonians consisting of (e) a quadratic polynomial plus a potential in the Sj\"ostrand class with (e&eb) bounded second order derivatives

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of stability of the frame property

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

Authors prove the stability of the frame property for small times and Hamiltonians consisting of (e) a quadratic polynomial plus a potential in the Sj\"ostrand class with (e&eb) bounded second order derivatives

G_{36} : Category one of **stability of the frame property for small times and Hamiltonians;** quadratic polynomial plus a potential in the Sj\"ostrand class with (e&eb) bounded second order derivatives

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of quadratic polynomial plus a potential in the Sj\"ostrand class with (e&eb) bounded second order derivatives **;stability of the frame property for small times and Hamiltonians**

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

Authors prove the stability of the frame property for small times and Hamiltonians consisting of a quadratic polynomial plus a potential in the Sj\"ostrand class with (e&eb) bounded second order derivatives

G_{40} : Category one of **stability of the frame property for small times and Hamiltonians consisting of a quadratic polynomial plus a potential in the Sj\"ostrand class;** bounded second order derivatives

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of bounded second order derivatives **;stability of the frame property for small times and Hamiltonians consisting of a quadratic polynomial plus a potential in the Sj\"ostrand class**

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

Authors investigate the completeness of Gabor systems with respect to (e&eb) several classes of window functions on (eb) rational lattices

G_{44} : Category one of **completeness of Gabor systems;** several classes of window functions on (eb) rational lattices

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of several classes of window functions on (eb) rational lattices **;completeness of Gabor systems**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$,	

$(a_{44}^{'})^{(9)}, (a_{45}^{'})^{(9)}, (a_{46}^{'})^{(9)}, (b_{44}^{'})^{(9)}, (b_{45}^{'})^{(9)}, (b_{46}^{'})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14}, t)\right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14}, t)\right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}, t)\right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G, t)\right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G, t)\right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G, t)\right] T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17}, t)\right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}, t)\right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}, t)\right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}), t\right)\right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}), t\right)\right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}), t\right)\right] T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}), t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21}, t)\right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}, t)\right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}, t)\right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}, t)\right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}, t)\right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}, t)\right] T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21}, t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23}, t) =$ First detritions factor	
Module Numbered Four	

The differential system of this model is now (Module numbered Four)	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\left[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\left[(a_{25}^{'})^{(4)}+(a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\left[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\left[(b_{25}^{'})^{(4)}-(b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\left[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t)=$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right)=$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\left[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\left[(a_{29}^{'})^{(5)}+(a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt}=(a_{30})^{(5)}G_{29}-\left[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[(b_{29}^{'})^{(5)}-(b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t)=$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}),t\right)=$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\left[(a_{33}^{'})^{(6)}+(a_{33}^{''})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\left[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\left[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt}=(b_{33})^{(6)}T_{32}-\left[(b_{33}^{'})^{(6)}-(b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt}=(b_{34})^{(6)}T_{33}-\left[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t)=$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt}=(a_{36})^{(7)}G_{37}-\left[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt}=(a_{37})^{(7)}G_{36}-\left[(a_{37}^{'})^{(7)}+(a_{37}^{''})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt}=(a_{38})^{(7)}G_{37}-\left[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37},t)\right]G_{38}$	*39*

$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}')^{(7)} - (b_{36}'')^{(7)}\left((G_{39}), t\right)\right] T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}')^{(7)} - (b_{37}'')^{(7)}\left((G_{39}), t\right)\right] T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}')^{(7)} - (b_{38}'')^{(7)}\left((G_{39}), t\right)\right] T_{38}$	42
$+(a_{36}'')^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}, t)\right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}')^{(8)} + (a_{41}'')^{(8)}(T_{41}, t)\right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}, t)\right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}')^{(8)} - (b_{40}'')^{(8)}\left((G_{43}), t\right)\right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}')^{(8)} - (b_{41}'')^{(8)}\left((G_{43}), t\right)\right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}')^{(8)} - (b_{42}'')^{(8)}\left((G_{43}), t\right)\right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	

$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}, t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45}, t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}, t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}')^{(9)} - (b_{44}'')^{(9)}\left((G_{47}), t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}')^{(9)} - (b_{45}'')^{(9)}\left((G_{47}), t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}')^{(9)} - (b_{46}'')^{(9)}\left((G_{47}), t\right)\right] T_{46}$	54
$+(a_{44}'')^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b_{44}'')^{(9)}\left((G_{47}), t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a_{13}')^{(1)} \boxed{+(a_{13}'')^{(1)}(T_{14}, t)} \boxed{+(a_{16}'')^{(2,2,)}(T_{17}, t)} \boxed{+(a_{20}'')^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a_{28}'')^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a_{32}'')^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a_{36}'')^{(7,7)}(T_{37}, t)} \boxed{+(a_{40}'')^{(8,8)}(T_{41}, t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a_{14}')^{(1)} \boxed{+(a_{14}'')^{(1)}(T_{14}, t)} \boxed{+(a_{17}'')^{(2,2,)}(T_{17}, t)} \boxed{+(a_{21}'')^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a_{29}'')^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a_{33}'')^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a_{37}'')^{(7,7)}(T_{37}, t)} \boxed{+(a_{41}'')^{(8,8)}(T_{41}, t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a_{15}')^{(1)} \boxed{+(a_{15}'')^{(1)}(T_{14}, t)} \boxed{+(a_{18}'')^{(2,2,)}(T_{17}, t)} \boxed{+(a_{22}'')^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a_{30}'')^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a_{34}'')^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a_{38}'')^{(7,7)}(T_{37}, t)} \boxed{+(a_{42}'')^{(8,8)}(T_{41}, t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{15}$	57
Where $\boxed{(a_{13}'')^{(1)}(T_{14}, t)}$, $\boxed{(a_{14}'')^{(1)}(T_{14}, t)}$, $\boxed{(a_{15}'')^{(1)}(T_{14}, t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}'')^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a_{17}'')^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a_{18}'')^{(2,2,)}(T_{17}, t)}$ are second augmentation coefficient for	

category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \quad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14} \quad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15} \quad 60$$

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8)}(G_{43},t)$ $-(b''_{41})^{(8,8)}(G_{43},t)$ $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a'_{16})^{(2)} +(a''_{16})^{(2)}(T_{17},t) +(a''_{13})^{(1,1,)}(T_{14},t) +(a''_{20})^{(3,3,3)}(T_{21},t) \\ +(a''_{24})^{(4,4,4,4,4)}(T_{25},t) +(a''_{28})^{(5,5,5,5,5)}(T_{29},t) +(a''_{32})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{36})^{(7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8)}(T_{41},t) +(a''_{44})^{(9,9)}(T_{45},t) \end{bmatrix} G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a'_{17})^{(2)} +(a''_{17})^{(2)}(T_{17},t) +(a''_{14})^{(1,1,)}(T_{14},t) +(a''_{21})^{(3,3,3)}(T_{21},t) \\ +(a''_{25})^{(4,4,4,4,4)}(T_{25},t) +(a''_{29})^{(5,5,5,5,5)}(T_{29},t) +(a''_{33})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{37})^{(7,7,7)}(T_{37},t) +(a''_{41})^{(8,8,8)}(T_{41},t) +(a''_{45})^{(9,9)}(T_{45},t) \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a'_{18})^{(2)} +(a''_{18})^{(2)}(T_{17},t) +(a''_{15})^{(1,1,)}(T_{14},t) +(a''_{22})^{(3,3,3)}(T_{21},t) \\ +(a''_{26})^{(4,4,4,4,4)}(T_{25},t) +(a''_{30})^{(5,5,5,5,5)}(T_{29},t) +(a''_{34})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{38})^{(7,7,7)}(T_{37},t) +(a''_{42})^{(8,8,8)}(T_{41},t) +(a''_{46})^{(9,9)}(T_{45},t) \end{bmatrix} G_{18}$	63
Where $+(a''_{16})^{(2)}(T_{17},t)$, $+(a''_{17})^{(2)}(T_{17},t)$, $+(a''_{18})^{(2)}(T_{17},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,)}(T_{14},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3 $+(a''_{44})^{(9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9)}(T_{45},t)$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b'_{16})^{(2)} -(b''_{16})^{(2)}(G_{19},t) -(b''_{13})^{(1,1,)}(G,t) -(b''_{20})^{(3,3,3,)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8)}(G_{43},t) -(b''_{44})^{(9,9)}(G_{47},t) \end{bmatrix} T_{16}$	64

$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1,2\ \ 3$

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ $are\ second\ \ augmentation\ coefficient\ \ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ \ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ $are\ fourth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ $are\ fifth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ $are\ sixth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ $are\ seventh\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ $are\ eighth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

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$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25}$$	77
$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$$	79
$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$$	80
$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation*	

coefficient for category 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[\begin{matrix}(b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{28}$	*82*
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[\begin{matrix}(b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{29}$	*83*
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[\begin{matrix}(b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{30}$	*84*
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition	

coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$	85
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$	86
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32}$	88

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$$ 89

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$$ 90

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 91

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$ 92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[\begin{matrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15} \qquad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13} \qquad 94$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b'_{44})^{(9)}\boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b'_{45})^{(9)}\boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)}\boxed{-(b''_{46})^{(9)}(G_{47},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b'_i)^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\|(a''_i)^{(1)}(T'_{14},t) - (a''_i)^{(1)}(T_{14},t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14} - T'_{14}\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b''_i)^{(1)}(G',t) - (b''_i)^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G - G'\|\|e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a''_i)^{(1)}(T'_{14},t)$ and $(a''_i)^{(1)}(T_{14},t)$. (T'_{14},t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a''_i)^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a''_i)^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a'_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$	
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i, j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17}, t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19}, t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2 \to \infty} (a_i'')^{(2)} (T_{17}, t) = (p_i)^{(2)}$	104
$\lim_{G \to \infty} (b_i'')^{(2)} ((G_{19}), t) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert (a_i'')^{(2)}(T_{17}', t) - (a_i'')^{(2)}(T_{17}, t) \rvert \leq (\hat{k}_{16})^{(2)} \lvert T_{17} - T_{17}' \rvert e^{-(\hat{M}_{16})^{(2)} t}$	107
$\lvert (b_i'')^{(2)}((G_{19})', t) - (b_i'')^{(2)}((G_{19}), t) \rvert < (\hat{k}_{16})^{(2)} \lvert\lvert (G_{19}) - (G_{19})' \rvert\rvert e^{-(\hat{M}_{16})^{(2)} t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}', t)$ and $(a_i'')^{(2)}(T_{17}, t)$. (T_{17}', t) and (T_{17}, t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)} + (a_i')^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i')^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}(T_{21}, t) = (p_i)^{(3)}$ $\lim_{\mathrm{G}\to\infty}(b_i'')^{(3)}(G_{23}, t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}', t) - (a_i'')^{(3)}(T_{21}, t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}', t) - (b_i'')^{(3)}(G_{23}, t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}', t)$ and $(a_i'')^{(3)}(T_{21}, t)$. (T_{21}', t) And (T_{21}, t) are points belonging to the interval $[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t) = (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\|(a_i'')^{(4)}(T_{25}',t) - (a_i'')^{(4)}(T_{25},t)\| \leq (\hat{k}_{24})^{(4)}\|T_{25} - T_{25}'\|e^{-(\hat{M}_{24})^{(4)}t}$ $\|(b_i'')^{(4)}((G_{27})',t) - (b_i'')^{(4)}((G_{27}),t)\| < (\hat{k}_{24})^{(4)}\|\|(G_{27}) - (G_{27})'\|\|e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and$(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}, \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i')^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i')^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i')^{(5)}, (a_i'')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (b_i'')^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i'')^{(5)}, (b_i'')^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29}, t) \le (p_i)^{(5)} \le (\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}), t) \le (r_i)^{(5)} \le (b_i')^{(5)} \le (\hat{B}_{28})^{(5)}$	122
$lim_{T_2 \to \infty}(a_i'')^{(5)}(T_{29}, t) = (p_i)^{(5)}$ $\lim_{G \to \infty}(b_i'')^{(5)}(G_{31}, t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\|(a_i'')^{(5)}(T_{29}', t) - (a_i'')^{(5)}(T_{29}, t)\| \le (\hat{k}_{28})^{(5)}\|T_{29} - T_{29}'\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i'')^{(5)}((G_{31})', t) - (b_i'')^{(5)}((G_{31}), t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31}) - (G_{31})'\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}', t)$ and $(a_i'')^{(5)}(T_{29}, t)$. (T_{29}', t) and (T_{29}, t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i'')^{(5)}(T_{29}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
<u>Definition of</u> $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)}$ *and* $(\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
$lim_{T_2 \to \infty} (a_i'')^{(6)}(T_{33}, t) = (p_i)^{(6)}$ $\lim_{G \to \infty} (b_i'')^{(6)}\big((G_{35}), t\big) = (r_i)^{(6)}$ **<u>Definition of</u>** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\rvert \leq (\hat{k}_{32})^{(6)}\lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}\big((G_{35}), t\big)\rvert < (\hat{k}_{32})^{(6)}\lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\big[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\big]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)},$ are positive constants	129

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(G) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (H) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(I) $\lim_{T_2 \to \infty} (a_i'')^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(J)* $\lim_{G \to \infty} (b_i'')^{(7)} ((G_{39}), t) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$	132
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)} t}$ $\lvert(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\rvert < (\hat{k}_{36})^{(7)} \lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (K) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (L) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}), t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2 \to \infty} (a_i'')^{(8)} (T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G \to \infty} (b_i'')^{(8)} \left((G_{43}), t\right) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert (a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t) \rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}' \rvert e^{-(\hat{M}_{40})^{(8)} t}$	142

$\lvert (b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}((G_{43}),t) \rvert < (\hat{k}_{40})^{(8)} \lvert\lvert (G_{43}) - (G_{43})' \rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}} , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)},\ (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i')^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i')^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)},\ (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i')^{(9)} \leq (\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t) = (p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t) = (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)}$ are positive constants and $i = 44,45,46$	
They satisfy Lipschitz condition:	

$$|(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)|\le(\hat{k}_{44})^{(9)}|T_{45}-T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}\big((G_{47}),t\big)|<(\hat{k}_{44})^{(9)}||(G_{47})-(G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and$(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $\left[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}\right]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ ,\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$$

Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)}and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(p_i)^{(9)},\ (r_i)^{(9)},i=44,45,46,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)}+(a_i')^{(9)}+\ (\hat{A}_{44})^{(9)}+\ (\hat{P}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}]<1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)}+(b_i')^{(9)}+\ (\hat{B}_{44})^{(9)}+\ (\hat{Q}_{44})^{(9)}\ \ (\hat{k}_{44})^{(9)}]<1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0),T_i(0)$:

$$G_i(t)\le\left(\hat{P}_{13}\right)^{(1)}e^{(\hat{M}_{13})^{(1)}t}\ ,\ \boxed{G_i(0)=G_i^0>0}$$

$$T_i(t)\le\ (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}\ ,\ \boxed{T_i(0)=T_i^0>0}$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0),T_i(0)$

$$G_i(t)\le\ (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}\ ,\ \ G_i(0)=G_i^0>0$$

$$T_i(t)\le\ (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}\ ,\ \ T_i(0)=T_i^0>0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t)\le\ (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}\ ,\ \ G_i(0)=G_i^0>0$$

$T_i(t) \leq \ (\hat{Q}_{20}\ )^{(3)} e^{(\hat{M}_{20}\ )^{(3)} t} \quad , \quad T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\ , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{24}\ )^{(4)} e^{(\hat{M}_{24}\ )^{(4)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24}\ )^{(4)} e^{(\hat{M}_{24}\ )^{(4)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\ , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{28}\ )^{(5)} e^{(\hat{M}_{28}\ )^{(5)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{28}\ )^{(5)} e^{(\hat{M}_{28}\ )^{(5)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\ , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{32}\ )^{(6)} e^{(\hat{M}_{32}\ )^{(6)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{32}\ )^{(6)} e^{(\hat{M}_{32}\ )^{(6)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\ , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{36}\ )^{(7)} e^{(\hat{M}_{36}\ )^{(7)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{36}\ )^{(7)} e^{(\hat{M}_{36}\ )^{(7)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\ , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{40}\ )^{(8)} e^{(\hat{M}_{40}\ )^{(8)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{40}\ )^{(8)} e^{(\hat{M}_{40}\ )^{(8)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\ , T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44}\right)^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}')^{(2)} - (b_{16}'')^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}')^{(2)} - (b_{17}'')^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}')^{(2)} - (b_{18}'')^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\, \hat{P}_{32}\,)^{(6)} \,, T_i^0 \leq (\, \hat{Q}_{32}\,)^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{32}\,)^{(6)} e^{(\, \hat{M}_{32}\,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{32}\,)^{(6)} e^{(\, \hat{M}_{32}\,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} \left(T_{33}(s_{(32)}), s_{(32)} \right) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} \left(T_{33}(s_{(32)}), s_{(32)} \right) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} \left(T_{33}(s_{(32)}), s_{(32)} \right) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\overline{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i\,,\, T_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\, \hat{P}_{36}\,)^{(7)} \,, T_i^0 \leq (\, \hat{Q}_{36}\,)^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{36}\,)^{(7)} e^{(\, \hat{M}_{36}\,)^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{36}\,)^{(7)} e^{(\, \hat{M}_{36}\,)^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)}\left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)}\left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $(1 + (a_{16})^{(2)} t) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0) e^{-(\hat{M}_{24})^{(4)} t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left[\left((\hat{P}_{24})^{(4)} + G_{25}^0 \right) e^{\left(-\frac{(\hat{P}_{24})^{(4)} + G_{25}^0}{G_{25}^0} \right)} + (\hat{P}_{24})^{(4)} \right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176

From which it follows that $(G_{32}(t) - G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)} + G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)} + (\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(b) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)}\left(G_{37}^0 + (\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)}t\right)G_{37}^0 + \frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t} - 1\right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)}\left(G_{41}^0 + (\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right] ds_{(40)} =$ $\left(1 + (a_{40})^{(8)}t\right)G_{41}^0 + \frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t} - 1\right)$	180
From which it follows that $(G_{40}(t) - G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)} + G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)} + (\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0 + \int_0^t \left[(a_{44})^{(9)}\left(G_{45}^0 + (\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right] ds_{(44)} =$ $\left(1 + (a_{44})^{(9)}t\right)G_{45}^0 + \frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t} - 1\right)$	
From which it follows that $(G_{44}(t) - G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)} + G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)} + (\hat{P}_{44})^{(9)}\right]$	

(G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for $G_{45}, G_{46}, T_{44}, T_{45}, T_{46}$	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)} + ((\hat{P}_{13})^{(1)} + G_j^0)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[((\hat{Q}_{13})^{(1)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{13})^{(1)}\right] \leq (\hat{Q}_{13})^{(1)}$	184
In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left((G^{(1)},T^{(1)}),(G^{(2)},T^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \|G_i^{(1)}(t) - G_i^{(2)}(t)\|e^{-(\hat{M}_{13})^{(1)}t}, \max_{t\in\mathbb{R}_+} \|T_i^{(1)}(t) - T_i^{(2)}(t)\|e^{-(\hat{M}_{13})^{(1)}t}\}$	185
Indeed if we denote **Definition of** $\tilde{G}, \tilde{T}$: $(\tilde{G}, \tilde{T}) = \mathcal{A}^{(1)}(G,T)$ It results $\|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\| \leq \int_0^t (a_{13})^{(1)} \|G_{14}^{(1)} - G_{14}^{(2)}\|e^{-(\hat{M}_{13})^{(1)}s_{(13)}}e^{(\hat{M}_{13})^{(1)}s_{(13)}}\, ds_{(13)} +$ $\int_0^t\{(a'_{13})^{(1)}\|G_{13}^{(1)} - G_{13}^{(2)}\|e^{-(\hat{M}_{13})^{(1)}s_{(13)}}e^{-(\hat{M}_{13})^{(1)}s_{(13)}} +$ $(a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)})\|G_{13}^{(1)} - G_{13}^{(2)}\|e^{-(\hat{M}_{13})^{(1)}s_{(13)}}e^{(\hat{M}_{13})^{(1)}s_{(13)}} +$ $G_{13}^{(2)}\|(a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) - (a''_{13})^{(1)}(T_{14}^{(2)}, s_{(13)})\|\, e^{-(\hat{M}_{13})^{(1)}s_{(13)}}e^{(\hat{M}_{13})^{(1)}s_{(13)}}\}ds_{(13)}$ Where $s_{(13)}$ represents integrand that is integrated over the interval [0, t] From the hypotheses it follows	
$\|G^{(1)} - G^{(2)}\|e^{-(\hat{M}_{13})^{(1)}t} \leq$ $\frac{1}{(\hat{M}_{13})^{(1)}}\left((a_{13})^{(1)} + (a'_{13})^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}\right)d\left((G^{(1)},T^{(1)};\ G^{(2)},T^{(2)})\right)$	186

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	
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Remark 36: The fact that we supposed $(a_{40}'')^{(8)}$ and $(b_{40}'')^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ *and* $(\widehat{Q}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
Remark 37 There does not exist any t where $G_i\,(t) = 0$ *and* $T_i\,(t) = 0$ it results $G_i\,(t) \ge G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)}-(a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \ge 0$ $T_i\,(t) \ge T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for $\mathrm{t} > 0$	275
Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \le \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)}G_{41}$ and by integrating $G_{41} \le \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \le \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}')^{(8)}$	276

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}\,(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\big((G_{43})(t),t(t),t\big) = (b_{42}')^{(8)}$	279
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) = \sup_i\{\max_{t\in\mathbb{R}_+}\|G_i^{(1)}(t) - G_i^{(2)}(t)\|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\|T_i^{(1)}(t) - T_i^{(2)}(t)\|e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})} : (\widetilde{(G_{47})},\widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}),(T_{47}))$ It results	

$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$
$\int_0^t \{(a_{44}')^{(9)} |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)} |(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a_{44}'')^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}| e^{-(\widehat{M}_{44})^{(9)} t} \leq \frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)} \right) d \left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)} \right) \right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)} \right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } \mathrm{t} > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t),t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t),t) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying

$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14},t) + (a_{14}^{''})^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$

Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: 281

By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations
$(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: 282

By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations
$(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- 283

If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by

$(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \; if \; (\nu_0)^{(1)} < (\nu_1)^{(1)}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \; (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$

and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\big((G_{19}), t\big) - (b_{17}^{''})^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\big(u^{(2)}\big)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \ \boldsymbol{if} \ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if} \ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \ \boldsymbol{if} \ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if} \ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}, \ \boldsymbol{if} \ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^{0} e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^{0} e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^{0} e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^{0} e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^{0}}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^{0} e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^{0}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^{0} e^{-(R_2)^{(2)}t}$	315
<u>**Definition of**</u> $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
<u>**Behavior of the solutions**</u> <u>**Theorem 3:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
<u>**Definition of**</u> $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the

roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$

and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$

Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- 321

If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by

$(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)}, \ \boldsymbol{if} \ (\nu_0)^{(3)} < (\nu_1)^{(3)}$

$(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}, \boldsymbol{if} \ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$

and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$

$(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$

and analogously 322

$(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}, \ \boldsymbol{if} \ (u_0)^{(3)} < (u_1)^{(3)}$

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if} \ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}, \ \boldsymbol{if} \ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$

Then the solution of global equations satisfies the inequalities

$G_{20}^0 e^{\left((S_1)^{(3)} - (p_{20})^{(3)}\right)t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$

$(p_i)^{(3)}$ is defined by equation

$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{\left((S_1)^{(3)} - (p_{20})^{(3)}\right)t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$ 323

$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}\left((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)}\right)}\left[e^{\left((S_1)^{(3)} - (p_{20})^{(3)}\right)t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ 324

$\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}\left((S_1)^{(3)} - (a_{22}')^{(3)}\right)}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$

$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{\left((R_1)^{(3)} + (r_{20})^{(3)}\right)t}}$ 325

$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{\left((R_1)^{(3)} + (r_{20})^{(3)}\right)t}$ 326

$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}\left((R_1)^{(3)} - (b_{22}')^{(3)}\right)}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ 327

$\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}\left((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)}\right)}\left[e^{\left((R_1)^{(3)} + (r_{20})^{(3)}\right)t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
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Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ $\boldsymbol{if}$ $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, $\boldsymbol{if}$ $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ $\boldsymbol{if}$ $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ $\boldsymbol{if}$ $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}$ $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>Definition of</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>Behavior of the solutions of equation</u> <u>Theorem 2:</u> If we denote and define <u>Definition of</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>Definition of</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
<u>**Definition of**</u> $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ <u>**Definition of**</u> $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},$ ***if*** $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},$ ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)},$ ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b'_{30})^{(5)}t}\right]+T_{30}^0 e^{-(b'_{30})^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
<u>Definition of</u> $(S_1)^{(5)},(S_2)^{(5)},(R_1)^{(5)},(R_2)^{(5)}$:- Where $(S_1)^{(5)}=(a_{28})^{(5)}(m_2)^{(5)}-(a'_{28})^{(5)}$ $(S_2)^{(5)}=(a_{30})^{(5)}-(p_{30})^{(5)}$ $(R_1)^{(5)}=(b_{28})^{(5)}(\mu_2)^{(5)}-(b'_{28})^{(5)}$ $(R_2)^{(5)}=(b'_{30})^{(5)}-(r_{30})^{(5)}$	348
<u>Behavior of the solutions of equation</u> **<u>Theorem 2:</u>** If we denote and define **<u>Definition of</u>** $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$: $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)}\leq-(a'_{32})^{(6)}+(a'_{33})^{(6)}-(a''_{32})^{(6)}(T_{33},t)+(a''_{33})^{(6)}(T_{33},t)\leq-(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)}\leq-(b'_{32})^{(6)}+(b'_{33})^{(6)}-(b''_{32})^{(6)}((G_{35}),t)-(b''_{33})^{(6)}((G_{35}),t)\leq-(\tau_1)^{(6)}$	349
<u>Definition of</u> $(\nu_1)^{(6)},(\nu_2)^{(6)},(u_1)^{(6)},(u_2)^{(6)},\nu^{(6)},u^{(6)}$: By $(\nu_1)^{(6)}>0,(\nu_2)^{(6)}<0$ and respectively $(u_1)^{(6)}>0,(u_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}(u^{(6)})^2+(\tau_1)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ and	350
<u>Definition of</u> $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}(u^{(6)})^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **<u>Definition of</u>** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},\boldsymbol{if}\ (\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)} t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)} t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)} t}\right] + G_{34}^0 e^{-(S_2)^{(6)} t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$T_{32}^0 e^{(R_1)^{(6)} t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)} + (r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)} t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)} + (r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)} - (b'_{34})^{(6)})}\left[e^{(R_1)^{(6)} t} - e^{-(b'_{34})^{(6)} t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)} t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)} + (r_{32})^{(6)} + (R_2)^{(6)})}\left[e^{((R_1)^{(6)} + (r_{32})^{(6)})t} - e^{-(R_2)^{(6)} t}\right] + T_{34}^0 e^{-(R_2)^{(6)} t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)} (m_2)^{(6)} - (a'_{32})^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)} (\mu_2)^{(6)} - (b'_{32})^{(6)}$ $(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)},\ \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a'_{38})^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a'_{38})^{(7)}t}] + G_{38}^0 e^{-(a'_{38})^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b'_{38})^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b'_{38})^{(7)}t}\right] + T_{38}^0 e^{-(b'_{38})^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a'_{36})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$ $(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}((G_{43}), t) - (b''_{41})^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and

Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$:

By $(\bar{\nu}_1)^{(8)} > 0\,, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0\,, (\bar{u}_2)^{(8)} < 0$ the

roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$

Definition of $(m_1)^{(8)}\,, (m_2)^{(8)}\,, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:-

If we define $(m_1)^{(8)}\,, (m_2)^{(8)}\,, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by

$$(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)} < (\nu_1)^{(8)}$$

$$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}\,, \boldsymbol{if}\ (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)},$$

and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$

$$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$$

and analogously 374

$$(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$$

$$(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\,, \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$$

and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$

$(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$

Then the solution of global equations satisfies the inequalities 375

$$G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$$

where $(p_i)^{(8)}$ is defined by equation

$$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t} \qquad 376$$

$$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)})}\left[e^{((S_1)^{(8)} - (p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq \right. \qquad 377$$

$$\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)} - (a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$$

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a_{44}')^{(9)} + (a_{45}')^{(9)} - (a_{44}'')^{(9)}(T_{45}, t) + (a_{45}'')^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b_{44}')^{(9)} + (b_{45}')^{(9)} - (b_{44}'')^{(9)}\big((G_{47}), t\big) - (b_{45}'')^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$	382
<u>**Definition of**</u> $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
<u>**Definition of**</u> $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ <u>**Definition of**</u> $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},$ ***if*** $(\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, $\boldsymbol{if}$ $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,
and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, $\boldsymbol{if}$ $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, $\boldsymbol{if}$ $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,
and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if}$ $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$
are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$
$$\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
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If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}')^{(3)} - (a_{21}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right) - (a_{21}'')^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
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If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
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Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

<u>Definition of</u> $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

<u>Proof</u> : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

<u>Definition of</u> $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)}$, $\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)}$, $\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

<u>Proof</u> : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

<u>Definition of</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

<u>Definition of</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G^0_{36}}{G^0_{37}}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$ if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41}, t)\right) - (a''_{41})^{(8)}(T_{41}, t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (b) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T^*_{33})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T^*_{33})]}$	
Definition and uniqueness of T^*_{37} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T^*_{37} for which $f(T^*_{37}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T^*_{37})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T^*_{37})]}$	500
Definition and uniqueness of T^*_{41} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T^*_{41} for which $f(T^*_{41}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T^*_{41})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T^*_{41})]}$	501
Definition and uniqueness of T^*_{45} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T^*_{45} for which $f(T^*_{45}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T^*_{45})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T^*_{45})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b'_{13})^{(1)}(b''_{14})^{(1)}(G) + (b'_{14})^{(1)}(b''_{13})^{(1)}(G)\right] + (b''_{13})^{(1)}(G)(b''_{14})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{14} such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b'_{16})^{(2)}(b''_{17})^{(2)}(G_{19}) + (b'_{17})^{(2)}(b''_{16})^{(2)}(G_{19})\right] + (b''_{16})^{(2)}(G_{19})(b''_{17})^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18})$, G_{16}, G_{18} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22})$, G_{20}, G_{22} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27}) + (b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right] + (b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26})$, G_{24}, G_{26} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31}) + (b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right] + (b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30})$, G_{28}, G_{30} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35}) + (b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right] + (b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34})$, G_{32}, G_{34} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39}) + (b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right] + (b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38})$, G_{36}, G_{38} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
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Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b'_{40})^{(8)} - (b''_{40})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b'_{42})^{(8)} - (b''_{42})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b'_{44})^{(9)} - (b''_{44})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b'_{46})^{(9)} - (b''_{46})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(1)}$ *and* $(b''_i)^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{14})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b''_i)^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -((a'_{13})^{(1)} + (p_{13})^{(1)})\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -((a'_{14})^{(1)} + (p_{14})^{(1)})\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -((a'_{15})^{(1)} + (p_{15})^{(1)})\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -((b'_{13})^{(1)} - (r_{13})^{(1)})\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(13)(j)} T_{13}^* \mathbb{G}_j)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -((b'_{14})^{(1)} - (r_{14})^{(1)})\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}(s_{(14)(j)} T_{14}^* \mathbb{G}_j)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -((b'_{15})^{(1)} - (r_{15})^{(1)})\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(15)(j)} T_{15}^* \mathbb{G}_j)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}')^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}')^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^*\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}')^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^*\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(4)}$ *and* $(b_i'')^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{25}'')^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial(b_i'')^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}')^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}')^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}')^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}')^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}')^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}')^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
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Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{29}'')^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial(b_i'')^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)} G^*_{28}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)} G^*_{29}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)} G^*_{30}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)} T^*_{28}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)} T^*_{29}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)} T^*_{30}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(6)}$ *and* $(b''_i)^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{33})^{(6)}}{\partial T_{33}}(T^*_{33}) = (q_{33})^{(6)} \quad , \frac{\partial (b''_i)^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)} G^*_{32}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)} G^*_{33}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)} G^*_{34}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)} T^*_{32}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)} T^*_{33}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)} T^*_{34}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ *and* $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{37})^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b''_i)^{(7)}}{\partial G_j} \left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a'_{36})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G_{36}^* \mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a'_{37})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G_{37}^* \mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G_{38}^* \mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T_{36}^* \mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T_{37}^* \mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T_{38}^* \mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}} (T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b''_i)^{(8)}}{\partial G_j} \left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G_{40}^* \mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G_{41}^* \mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)} G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)} T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)} T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)} T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^*\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)} G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)} G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)} G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)} T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)} T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)} T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)} G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)} G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right) s_{(14),(14)} T_{14}^{*} + (b_{14})^{(1)} s_{(13),(14)} T_{14}^{*}\right)$	

$+\left(\left((\lambda)^{(1)}+(a_{14}')^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}')^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}')^{(1)}+(a_{14}')^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}')^{(1)}+(b_{14}')^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}')^{(1)}+(a_{14}')^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$

$+\left((\lambda)^{(1)}+(a_{13}')^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}')^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$

+

$\left((\lambda)^{(2)}+(b_{18}')^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}')^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}')^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}')^{(2)}+(b_{17}')^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}G_{18}$

$+\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\right)\}=0$

+

$\left((\lambda)^{(3)}+(b_{22}')^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}')^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$$

$$+((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$$

$+$

$$((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)})$$

$$\left[\left(\left((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$$

$$+\left(\left((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$$

$$+((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$$

$+$

$$((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)})$$

$$\left[\left(\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$$

$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$

$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$

$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$

$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$

$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$

$+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$

$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$

+

$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$

$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$

$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$

$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$

$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$

$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$

$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$

+

$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$

$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2} + \left((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2} + \left((b_{44}^{'})^{(9)} + (b_{45}^{'})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2} + \left((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\} = 0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION THREE

Completeness Of Gabor Systems

INTRODUCTION—VARIABLES USED

Completeness of Gabor systems Karlheinz Gröchenig, Antti Haimi, José Luis Romero

(1) Authors investigate the completeness of Gabor systems with respect to (e&eb) several classes of window functions on (eb) rational lattices.
(2) main results show that the time-frequency shifts of (e) every finite linear combination of Hermite functions with respect to (e&eb) a rational lattice are complete in L2(R), thus generalizing (e&eb) a remark of von Neumann (and proved by Bargmann, Perelomov et al.).
(3) An analogous result is proven for (e) functions that factor into (e&eb) certain rational functions and the Gaussian.
(4) The results are also interesting from (e) a conceptual point of view since they show a vast difference between the completeness and (e&eb) the frame property of a Gabor system. In the terminology of physics we prove new results about the completeness of coherent state subsystems. Subjects: Mathematical Physics (math-ph) MSC classes: 42C30, 42C15, 81R30 Cite

as: arXiv: 1507.02124 [math-ph] (or arXiv: 1507.02124v3 [math-ph] for this version)	
NOTATION	
Module One Authors investigate the completeness of Gabor systems with respect to several classes of window functions on (eb) rational lattices	
G_{13} : Category one of **completeness of Gabor systems with respect to several classes of window functions;** rational lattices G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of rational lattices **;completeness of Gabor systems with respect to several classes of window functions** T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two main results show that the time-frequency shifts of (e) every finite linear combination of Hermite functions with respect to (e&eb) a rational lattice are complete in L2(R), thus generalizing (e&eb) a remark of von Neumann (and proved by Bargmann, Perelomov et al.)	
G_{16} : Category one of every finite linear combination of Hermite functions with respect to (e&eb) a rational lattice are complete in L2(R), thus generalizing (e&eb) a remark of von Neumann (and proved by Bargmann, Perelomov et al.) G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of main results show that the time-frequency shifts T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three main results show that the time-frequency shifts of every finite linear combination of Hermite functions with respect to (e&eb) a rational lattice are complete in L2(R), thus generalizing (e&eb) a remark of von Neumann (and proved by Bargmann, Perelomov et al.)	
G_{20} : Category one of **main results show that the time-frequency shifts of every finite linear combination of Hermite functions;** rational lattice are complete in L2(R), thus generalizing (e&eb) a remark of von Neumann (and proved by Bargmann, Perelomov et al.) G_{21} : Category two of SAS G_{22} : Category three of SAS	

T_{20} : Category one of rational lattice are complete in L2(R), thus generalizing (e&eb) a remark of von Neumann (and proved by Bargmann, Perelomov et al.);**main results show that the time-frequency shifts of every finite linear combination of Hermite functions** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four main results show that the time-frequency shifts of every finite linear combination of Hermite functions with respect to a rational lattice are complete in L2(R), thus generalizing (e&eb) a **remark of von Neumann (and proved by Bargmann, Perelomov et al.)**	
G_{24} : Category one of main results show that the time-frequency shifts of every finite linear combination of Hermite functions with respect to a rational lattice are complete in L2(R), thus generalizing; **remark of von Neumann (and proved by Bargmann, Perelomov et al.)** G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of **remark of von Neumann (and proved by Bargmann, Perelomov et al.);**main results show that the time-frequency shifts of every finite linear combination of Hermite functions with respect to a rational lattice are complete in L2(R), thus generalizing T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five An analogous result is proven for functions that factor into (e&eb) certain rational functions and the Gaussian	
G_{28} : Category one of **analogous result is proven for functions that factor;** certain rational functions and the Gaussian G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of certain rational functions and the Gaussian **;analogous result is proven for functions that factor** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six The results are also interesting from (e) a conceptual point of view since they show a vast difference between the completeness and (e&eb) the frame property of a Gabor system.	

In the terminology of physics we prove new results about the completeness of coherent state subsystems. Subjects: Mathematical Physics (math-ph) MSC classes: 42C30, 42C15, 81R30 Cite as: arXiv: 1507.02124 [math-ph] (or arXiv: 1507.02124v3 [math-ph] for this version)	
G_{32} : Category one of **completeness;** frame property of a Gabor system G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of frame property of a Gabor system **;completeness** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven **The Black-Scholes Equation and Certain Quantum Hamiltonians Juan M. Romero, O. Gonzalez-Gaxiola, J. Ruiz de Chavez, R. Bernal-Jaquez** (1) In this paper a quantum mechanics is built by means of (e) a non-Hermitian momentum operator. (2) Authors have shown that it is possible to construct two Hermitian and two non-Hermitian type of Hamiltonians using (e) this momentum operator. (3) Authors can construct a generalized supersymmetric quantum mechanics that has a dual based on (e) these Hamiltonians. (4) In addition, it is shown that the non-Hermitian Hamiltonians of this theory can be related to (e&eb) Hamiltonians that naturally arise in the so-called quantum finance (5) Subjects: Mathematical Physics (math-ph); High Energy Physics - Theory (hep-th); Quantum Physics (quant-ph) MSC classes: 81Q12, 81Q60, 81Q65 Journal reference: International Journal of Pure and Applied Mathematics (IJPAM): Volume 67, No. 2 (2011) Cite as:arXiv:1002.1667 [math-ph] (or arXiv:1002.1667v2 [math-ph] for this version) quantum mechanics is built by means of (e) a non-Hermitian momentum operator	
G_{36} : Category one of **quantum mechanics is built;** non-Hermitian momentum operator G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of non-Hermitian momentum operator; **quantum mechanics is built** T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight Authors have shown that it is possible to construct two Hermitian and two non-Hermitian type of	

Hamiltonians using (e) this momentum operator	
G_{40} : Category one of two Hermitian and two non-Hermitian type of Hamiltonians; **momentum operator** G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of **momentum operator** ;two Hermitian and two non-Hermitian type of Hamiltonians T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine Authors can construct a generalized supersymmetric quantum mechanics that has a dual based on (e) these Hamiltonians	
G_{44} : Category one of these Hamiltonians G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of generalized supersymmetric quantum mechanics that has a dual T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	

Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t) \right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}, t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}, t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}, t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\big((G_{19}), t\big) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\big((G_{19}), t\big) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\big((G_{19}), t\big) \right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\big((G_{19}), t\big) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}, t) \right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}, t) \right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}, t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}, t) \right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}, t) \right] T_{22}$	18
$+(a''_{20})^{(3)}(T_{21}, t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23}, t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25}, t) \right] G_{24}$	19

$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a''_{24})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*

$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}')^{(7)} - (b_{38}'')^{(7)} \left((G_{39}), t \right) \right] T_{38}$	42
$+(a_{36}'')^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}')^{(8)} + (a_{40}'')^{(8)} (T_{41}, t) \right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}')^{(8)} + (a_{41}'')^{(8)} (T_{41}, t) \right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}')^{(8)} + (a_{42}'')^{(8)} (T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}')^{(8)} - (b_{40}'')^{(8)} \left((G_{43}), t \right) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}')^{(8)} - (b_{41}'')^{(8)} \left((G_{43}), t \right) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}')^{(8)} - (b_{42}'')^{(8)} \left((G_{43}), t \right) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}')^{(9)} + (a_{44}'')^{(9)} (T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}')^{(9)} + (a_{45}'')^{(9)} (T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}')^{(9)} + (a_{46}'')^{(9)} (T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}')^{(9)} - (b_{44}'')^{(9)} \left((G_{47}), t \right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}')^{(9)} - (b_{45}'')^{(9)} \left((G_{47}), t \right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}')^{(9)} - (b_{46}'')^{(9)} \left((G_{47}), t \right) \right] T_{46}$	54
$+(a_{44}'')^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b_{44}'')^{(9)}\left((G_{47}), t \right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a_{13}')^{(1)} \boxed{+(a_{13}'')^{(1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a_{14}')^{(1)} \boxed{+(a_{14}'')^{(1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{37}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a_{15}')^{(1)} \boxed{+(a_{15}'')^{(1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	57
Where $\boxed{(a_{13}'')^{(1)}(T_{14},t)}$, $\boxed{(a_{14}'')^{(1)}(T_{14},t)}$, $\boxed{(a_{15}'')^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}'')^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{24}'')^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}'')^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a_{40}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}'')^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b_{13}')^{(1)}\boxed{-(b_{13}'')^{(1)}(G,t)}\ \boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}\ \boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)}\boxed{-(b_{40}'')^{(8,8)}(G_{43},t)}\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b_{14}')^{(1)}\boxed{-(b_{14}'')^{(1)}(G,t)}\ \boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}\ \boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)}\boxed{-(b_{41}'')^{(8,8)}(G_{43},t)}\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b_{15}')^{(1)}\boxed{-(b_{15}'')^{(1)}(G,t)}\ \boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}\ \boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}\boxed{-(b_{42}'')^{(8,8)}(G_{43},t)}\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$	*60*
Where $\boxed{-(b_{13}'')^{(1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{40}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{41}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{42}'')^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a_{16}')^{(2)} \boxed{+(a_{16}'')^{(2)}(T_{17},t)} \boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{16}$$	61
$$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a_{17}')^{(2)} \boxed{+(a_{17}'')^{(2)}(T_{17},t)} \boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$$	62
$$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a_{18}')^{(2)} \boxed{+(a_{18}'')^{(2)}(T_{17},t)} \boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$$	63
Where $\boxed{+(a_{16}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{44}'')^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b_{16}')^{(2)} \boxed{-(b_{16}'')^{(2)}(G_{19},t)} \boxed{-(b_{13}'')^{(1,1,)}(G,t)} \boxed{-(b_{20}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16}$$	64
$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b_{17}')^{(2)} \boxed{-(b_{17}'')^{(2)}(G_{19},t)} \boxed{-(b_{14}'')^{(1,1,)}(G,t)} \boxed{-(b_{21}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17}$$	65

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$$ 66

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$$ 67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$$ 68

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22}$$ 69

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3 $+(a''_{40})^{(8,8,8,8)}(T_{41},t)$,$+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3 $+(a''_{44})^{(9,9,9)}(T_{45},t)$,$+(a''_{45})^{(9,9,9)}(T_{45},t)$,$+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} -(b''_{20})^{(3)}(G_{23},t) -(b''_{16})^{(2,2,2)}(G_{19},t) -(b''_{13})^{(1,1,1,)}(G,t) \\ -(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8,8)}(G_{43},t) -(b''_{44})^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{20}$	*70*
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} -(b''_{21})^{(3)}(G_{23},t) -(b''_{17})^{(2,2,2)}(G_{19},t) -(b''_{14})^{(1,1,1,)}(G,t) \\ -(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t) -(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t) -(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{37})^{(7,7,7,7)}(G_{39},t) -(b''_{41})^{(8,8,8,8)}(G_{43},t) -(b''_{45})^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{21}$	*71*
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} -(b''_{22})^{(3)}(G_{23},t) -(b''_{18})^{(2,2,2)}(G_{19},t) -(b''_{15})^{(1,1,1,)}(G,t) \\ -(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t) -(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t) -(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{38})^{(7,7,7,7)}(G_{39},t) -(b''_{42})^{(8,8,8,8)}(G_{43},t) -(b''_{46})^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{22}$	*72*
$-(b''_{20})^{(3)}(G_{23},t)$, $-(b''_{21})^{(3)}(G_{23},t)$, $-(b''_{22})^{(3)}(G_{23},t)$ *are first detrition coefficients for category 1, 2 and 3* $-(b''_{16})^{(2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2)}(G_{19},t)$ *are second detrition coefficients for category 1, 2 and 3* $-(b''_{13})^{(1,1,1,)}(G,t)$, $-(b''_{14})^{(1,1,1,)}(G,t)$, $-(b''_{15})^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3* $-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3* $-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3* $-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3* $-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$ $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8,8,8)}(G_{43},t)$,$-(b''_{41})^{(8,8,8,8)}(G_{43},t)$,$-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3	

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\begin{bmatrix}(a'_{24})^{(4)}+(a''_{24})^{(4)}(T_{25},t)+(a''_{28})^{(5,5,)}(T_{29},t)+(a''_{32})^{(6,6,)}(T_{33},t)\\+(a''_{13})^{(1,1,1,1)}(T_{14},t)+(a''_{16})^{(2,2,2,2)}(T_{17},t)+(a''_{20})^{(3,3,3,3)}(T_{21},t)\\+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)+(a''_{44})^{(9,9,9,9)}(T_{45},t)\end{bmatrix}G_{24}$	73
$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\begin{bmatrix}(a'_{25})^{(4)}+(a''_{25})^{(4)}(T_{25},t)+(a''_{29})^{(5,5,)}(T_{29},t)+(a''_{33})^{(6,6)}(T_{33},t)\\+(a''_{14})^{(1,1,1,1)}(T_{14},t)+(a''_{17})^{(2,2,2,2)}(T_{17},t)+(a''_{21})^{(3,3,3,3)}(T_{21},t)\\+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)+(a''_{45})^{(9,9,9,9)}(T_{45},t)\end{bmatrix}G_{25}$	74
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\begin{bmatrix}(a'_{26})^{(4)}+(a''_{26})^{(4)}(T_{25},t)+(a''_{30})^{(5,5,)}(T_{29},t)+(a''_{34})^{(6,6,)}(T_{33},t)\\+(a''_{15})^{(1,1,1,1)}(T_{14},t)+(a''_{18})^{(2,2,2,2)}(T_{17},t)+(a''_{22})^{(3,3,3,3)}(T_{21},t)\\+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)+(a''_{46})^{(9,9,9,9)}(T_{45},t)\end{bmatrix}G_{26}$	75
$(a''_{24})^{(4)}(T_{25},t)$, $(a''_{25})^{(4)}(T_{25},t)$, $(a''_{26})^{(4)}(T_{25},t)$ *are first augmentation coefficients category* 1, 2 3 $+(a''_{28})^{(5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{32})^{(6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{13})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1)}(T_{14},t)$ *are fourth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{16})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2)}(T_{17},t)$ *are fifth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{20})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3)}(T_{21},t)$ *are sixth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$ *are seventh augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)$ *are eighth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{46})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9)}(T_{45},t)$ are ninth detrition coefficients for category 1 2 3	
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\begin{bmatrix}(b'_{24})^{(4)}-(b''_{24})^{(4)}(G_{27},t)-(b''_{28})^{(5,5,)}(G_{31},t)-(b''_{32})^{(6,6,)}(G_{35},t)\\-(b''_{13})^{(1,1,1,1)}(G,t)-(b''_{16})^{(2,2,2,2)}(G_{19},t)-(b''_{20})^{(3,3,3,3)}(G_{23},t)\\-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)-(b''_{44})^{(9,9,9,9)}(G_{47},t)\end{bmatrix}T_{24}$	76
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\begin{bmatrix}(b'_{25})^{(4)}-(b''_{25})^{(4)}(G_{27},t)-(b''_{29})^{(5,5,)}(G_{31},t)-(b''_{33})^{(6,6,)}(G_{35},t)\\-(b''_{14})^{(1,1,1,1)}(G,t)-(b''_{17})^{(2,2,2,2)}(G_{19},t)-(b''_{21})^{(3,3,3,3)}(G_{23},t)\\-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)-(b''_{45})^{(9,9,9,9)}(G_{47},t)\end{bmatrix}T_{25}$	77

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[\begin{matrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{28} \quad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{29} \quad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{30} \quad 81$$

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\ \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28} \quad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\ \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\ \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30} \quad 84$$

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{32}$	*85*
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{33}$	*86*
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{34}$	*87*
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{32}$	*88*

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$$	89
$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$$	90

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$	91
$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$	92

$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	*93*
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second

augmentation coefficient for category 1, 2 and 3

$+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3

$+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ $+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ $+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for 1,2,3

$+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$ are eighth augmentation coefficient for 1,2,3

$+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \; \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \; \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \; \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \; \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \; \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \; \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \; \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \; \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \; \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \; \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \; \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \; \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \; \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \; \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \; \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \; \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \; \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \; \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3

$-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3

$-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3

$-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b_{44}^{'})^{(9)} \boxed{-(b_{44}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \begin{bmatrix} (b_{45}^{'})^{(9)} \boxed{-(b_{45}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \begin{bmatrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)},(a'_i)^{(1)},(a''_i)^{(1)},(b_i)^{(1)},(b'_i)^{(1)},(b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)},(b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b'_i)^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition: $\lvert(a''_i)^{(1)}(T'_{14},t) - (a''_i)^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T'_{14}\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b''_i)^{(1)}(G',t) - (b''_i)^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a''_i)^{(1)}(T'_{14},t)$ and $(a''_i)^{(1)}(T_{14},t)$. (T'_{14},t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a''_i)^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a''_i)^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \ , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a'_i)^{(1)},(b_i)^{(1)},(b'_i)^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}((G_{19}),t) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}}$ are positive constants and $\boxed{i = 16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19}) - (G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)}$ and $(\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i^{'})^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i^{'})^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, (\mathrm{r_i})^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty} (a_i^{''})^{(3)} (T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty} (b_i^{''})^{(3)} (G_{23}, t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20,21,22}$	113
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(3)}(T_{21}^{'}, t) - (a_i^{''})^{(3)}(T_{21}, t)\rvert \leq (\hat{k}_{20})^{(3)} \lvert T_{21} - T_{21}^{'}\rvert e^{-(\hat{M}_{20})^{(3)} t}$ $\lvert(b_i^{''})^{(3)}(G_{23}{'}, t) - (b_i^{''})^{(3)}(G_{23}, t)\rvert < (\hat{k}_{20})^{(3)} \lvert\lvert G_{23} - G_{23}{'}\rvert\rvert e^{-(\hat{M}_{20})^{(3)} t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and $(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25}, t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}), t) \leq (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2 \to \infty} (a_i^{''})^{(4)} (T_{25}, t) = (p_i)^{(4)}$ $\lim_{G \to \infty} (b_i^{''})^{(4)} ((G_{27}), t) = (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\|(a_i^{''})^{(4)}(T_{25}^{'}, t) - (a_i^{''})^{(4)}(T_{25}, t)\| \leq (\hat{k}_{24})^{(4)} \|T_{25} - T_{25}^{'}\| e^{-(\hat{M}_{24})^{(4)} t}$ $\|(b_i^{''})^{(4)}((G_{27})^{'}, t) - (b_i^{''})^{(4)}((G_{27}), t)\| < (\hat{k}_{24})^{(4)} \|\|(G_{27}) - (G_{27})^{'}\|\| e^{-(\hat{M}_{24})^{(4)} t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'}, t)$ and $(a_i^{''})^{(4)}(T_{25}, t)$. $(T_{25}^{'}, t)$ and (T_{25}, t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26$, satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i^{'})^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)} (\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i^{'})^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)} (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29}, t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}), t) \leq (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	122
$lim_{T_2 \to \infty} (a_i^{''})^{(5)} (T_{29}, t) = (p_i)^{(5)}$ $\lim_{G \to \infty} (b_i^{''})^{(5)} (G_{31}, t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(5)}(T_{29}^{'}, t) - (a_i^{''})^{(5)}(T_{29}, t)\rvert \leq (\hat{k}_{28})^{(5)} \lvert T_{29} - T_{29}^{'} \rvert e^{-(\hat{M}_{28})^{(5)} t}$ $\lvert(b_i^{''})^{(5)}((G_{31})^{'}, t) - (b_i^{''})^{(5)}((G_{31}), t)\rvert < (\hat{k}_{28})^{(5)} \lvert\lvert(G_{31}) - (G_{31})^{'} \rvert\rvert e^{-(\hat{M}_{28})^{(5)} t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'}, t)$ and $(a_i^{''})^{(5)}(T_{29}, t)$. $(T_{29}^{'}, t)$ and (T_{29}, t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
$lim_{T_2 \to \infty} (a_i'')^{(6)} (T_{33}, t) = (p_i)^{(6)}$ $\lim_{G \to \infty} (b_i'')^{(6)} ((G_{35}), t) = (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	128
They satisfy Lipschitz condition: $\lvert (a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert (b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}((G_{35}), t)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert (G_{35}) - (G_{35})' \rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants	129

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}, \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and\ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)}(\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)}(\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(M) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (N) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \le (p_i)^{(7)} \le (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \le (r_i)^{(7)} \le (b_i')^{(7)} \le (\hat{B}_{36})^{(7)}$	131
(O) $\lim_{T_2 \to \infty} (a_i'')^{(7)}(T_{37}, t) = (p_i)^{(7)}$ *(P)* $\lim_{G \to \infty} (b_i'')^{(7)}((G_{39}), t) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\rvert \le (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (Q) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (R) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}), t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2 \to \infty} (a_i'')^{(8)}(T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G \to \infty} (b_i'')^{(8)}((G_{43}), t) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert (a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t) \rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}' \rvert e^{-(\hat{M}_{40})^{(8)} t}$	142

$\|(b_i^{''})^{(8)}((G_{43})',t) - (b_i^{''})^{(8)}((G_{43}),t)\| < (\hat{k}_{40})^{(8)}\|\|(G_{43}) - (G_{43})'\|\|e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}',t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i')^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i')^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i^{''})^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i^{''})^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i^{''})^{(9)},(b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t) \le (p_i)^{(9)} \le (\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t) \le (r_i)^{(9)} \le (b_i')^{(9)} \le (\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i^{''})^{(9)}(T_{45},t) = (p_i)^{(9)}$ $\lim_{G\to\infty}(b_i^{''})^{(9)}(G_{47},t) = (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i = 44,45,46$	
They satisfy Lipschitz condition:	

$|(a_i'')^{(9)}(T_{45}',t) - (a_i'')^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$

$|(b_i'')^{(9)}((G_{47})',t) - (b_i'')^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0), T_i(0)$:

$G_i(t) \leq (\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $G_i(0) = G_i^0 > 0$

$T_i(t) \leq (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $T_i(0) = T_i^0 > 0$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0), T_i(0)$

$G_i(t) \leq (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$

$T_i(t) \leq (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$G_i(t) \leq (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$

$T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$,$T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{13}\left(s_{(13)}\right) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}\left(s_{(13)}\right) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{14}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{15}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}\left(s_{(13)}\right) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)} \left(G\left(s_{(13)}\right), s_{(13)}\right) \right) T_{13}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}\left(s_{(13)}\right) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)} \left(G\left(s_{(13)}\right), s_{(13)}\right) \right) T_{14}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}\left(s_{(13)}\right) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)} \left(G\left(s_{(13)}\right), s_{(13)}\right) \right) T_{15}\left(s_{(13)}\right) \right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$,$T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)} \left(T_{17}\left(s_{(16)}\right), s_{(16)}\right) \right) G_{16}\left(s_{(16)}\right) \right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}\left(s_{(16)}\right) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)} \left(T_{17}\left(s_{(16)}\right), s_{(17)}\right) \right) G_{17}\left(s_{(16)}\right) \right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \Big[(a_{18})^{(2)} G_{17}(s_{(16)}) - \Big((a'_{18})^{(2)} + (a''_{18})^{(2)}\big(T_{17}(s_{(16)}), s_{(16)}\big)\Big) G_{18}(s_{(16)})\Big] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \Big[(b_{16})^{(2)} T_{17}(s_{(16)}) - \Big((b'_{16})^{(2)} - (b''_{16})^{(2)}\big(G_{19}(s_{(16)}), s_{(16)}\big)\Big) T_{16}(s_{(16)})\Big] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \Big[(b_{17})^{(2)} T_{16}(s_{(16)}) - \Big((b'_{17})^{(2)} - (b''_{17})^{(2)}\big(G_{19}(s_{(16)}), s_{(16)}\big)\Big) T_{17}(s_{(16)})\Big] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \Big[(b_{18})^{(2)} T_{17}(s_{(16)}) - \Big((b'_{18})^{(2)} - (b''_{18})^{(2)}\big(G_{19}(s_{(16)}), s_{(16)}\big)\Big) T_{18}(s_{(16)})\Big] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \leq (\hat{P}_{20})^{(3)}\,, T_i^0 \leq (\hat{Q}_{20})^{(3)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \Big[(a_{20})^{(3)} G_{21}(s_{(20)}) - \Big((a'_{20})^{(3)} + a''_{20})^{(3)}\big(T_{21}(s_{(20)}), s_{(20)}\big)\Big) G_{20}(s_{(20)})\Big] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \Big[(a_{21})^{(3)} G_{20}(s_{(20)}) - \Big((a'_{21})^{(3)} + (a''_{21})^{(3)}\big(T_{21}(s_{(20)}), s_{(20)}\big)\Big) G_{21}(s_{(20)})\Big] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \Big[(a_{22})^{(3)} G_{21}(s_{(20)}) - \Big((a'_{22})^{(3)} + (a''_{22})^{(3)}\big(T_{21}(s_{(20)}), s_{(20)}\big)\Big) G_{22}(s_{(20)})\Big] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \Big[(b_{20})^{(3)} T_{21}(s_{(20)}) - \Big((b'_{20})^{(3)} - (b''_{20})^{(3)}\big(G_{23}(s_{(20)}), s_{(20)}\big)\Big) T_{20}(s_{(20)})\Big] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \Big[(b_{21})^{(3)} T_{20}(s_{(20)}) - \Big((b'_{21})^{(3)} - (b''_{21})^{(3)}\big(G_{23}(s_{(20)}), s_{(20)}\big)\Big) T_{21}(s_{(20)})\Big] ds_{(20)}$	
$\bar{\mathrm{T}}_{22}(\mathrm{t}) = \mathrm{T}_{22}^0 + \int_0^t \Big[(b_{22})^{(3)} T_{21}(s_{(20)}) - \Big((b'_{22})^{(3)} - (b''_{22})^{(3)}\big(G_{23}(s_{(20)}), s_{(20)}\big)\Big) T_{22}(s_{(20)})\Big] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \leq (\hat{P}_{24})^{(4)}\,, T_i^0 \leq (\hat{Q}_{24})^{(4)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{\mathrm{T}}_{26}(\mathrm{t}) = \mathrm{T}_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i, T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0\le(\hat{P}_{32})^{(6)}\ ,T_i^0\le(\hat{Q}_{32})^{(6)},$	
$0\le G_i(t)-G_i^0\le(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$	
$0\le T_i(t)-T_i^0\le(\hat{Q}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$	
By $\bar{G}_{32}(t)=G_{32}^0+\int_0^t\left[(a_{32})^{(6)}G_{33}(s_{(32)})-\left((a_{32}^{'})^{(6)}+a_{32}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{32}(s_{(32)})\right]ds_{(32)}$	164
$\bar{G}_{33}(t)=G_{33}^0+\int_0^t\left[(a_{33})^{(6)}G_{32}(s_{(32)})-\left((a_{33}^{'})^{(6)}+(a_{33}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{33}(s_{(32)})\right]ds_{(32)}$	
$\bar{G}_{34}(t)=G_{34}^0+\int_0^t\left[(a_{34})^{(6)}G_{33}(s_{(32)})-\left((a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{34}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{32}(t)=T_{32}^0+\int_0^t\left[(b_{32})^{(6)}T_{33}(s_{(32)})-\left((b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{32}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{33}(t)=T_{33}^0+\int_0^t\left[(b_{33})^{(6)}T_{32}(s_{(32)})-\left((b_{33}^{'})^{(6)}-(b_{33}^{''})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{33}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{34}(t)=T_{34}^0+\int_0^t\left[(b_{34})^{(6)}T_{33}(s_{(32)})-\left((b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{34}(s_{(32)})\right]ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i:\mathbb{R}_+\to\mathbb{R}_+$ which satisfy	
$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0\le(\hat{P}_{36})^{(7)}\ ,T_i^0\le(\hat{Q}_{36})^{(7)},$	
$0\le G_i(t)-G_i^0\le(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$	
$0\le T_i(t)-T_i^0\le(\hat{Q}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$	
By $\bar{G}_{36}(t)=G_{36}^0+\int_0^t\left[(a_{36})^{(7)}G_{37}(s_{(36)})-\left((a_{36}^{'})^{(7)}+a_{36}^{''})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right)G_{36}(s_{(36)})\right]ds_{(36)}$	165
$\bar{G}_{37}(t)=G_{37}^0+\int_0^t\left[(a_{37})^{(7)}G_{36}(s_{(36)})-\left((a_{37}^{'})^{(7)}+(a_{37}^{''})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right)G_{37}(s_{(36)})\right]ds_{(36)}$	
$\bar{G}_{38}(t)=G_{38}^0+\int_0^t\left[(a_{38})^{(7)}G_{37}(s_{(36)})-\left((a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right)G_{38}(s_{(36)})\right]ds_{(36)}$	
$\bar{T}_{36}(t)=T_{36}^0+\int_0^t\left[(b_{36})^{(7)}T_{37}(s_{(36)})-\left((b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}(G_{39}(s_{(36)}),s_{(36)})\right)T_{36}(s_{(36)})\right]ds_{(36)}$	

$$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}\left(s_{(36)}\right) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left(G_{39}\left(s_{(36)}\right), s_{(36)}\right)\right) T_{37}\left(s_{(36)}\right)\right] ds_{(36)}$$

$$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left(G_{39}\left(s_{(36)}\right), s_{(36)}\right)\right) T_{38}\left(s_{(36)}\right)\right] ds_{(36)}$$

Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0 \,,\ T_i(0) = T_i^0 \,,\ G_i^0 \leq (\hat{P}_{40})^{(8)} \,, T_i^0 \leq (\hat{Q}_{40})^{(8)},$$

$$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$$

$$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$$

By 166

$$\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}\left(s_{(40)}\right) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{40}\left(s_{(40)}\right)\right] ds_{(40)}$$

$$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}\left(s_{(40)}\right) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{41}\left(s_{(40)}\right)\right] ds_{(40)}$$

$$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}\left(s_{(40)}\right) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{42}\left(s_{(40)}\right)\right] ds_{(40)}$$

$$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}\left(s_{(40)}\right) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{40}\left(s_{(40)}\right)\right] ds_{(40)}$$

$$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}\left(s_{(40)}\right) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{41}\left(s_{(40)}\right)\right] ds_{(40)}$$

$$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}\left(s_{(40)}\right) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{42}\left(s_{(40)}\right)\right] ds_{(40)}$$

Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$

Proof: 166 A

Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0 \,,\ T_i(0) = T_i^0 \,,\ G_i^0 \leq (\hat{P}_{44})^{(9)} \,, T_i^0 \leq (\hat{Q}_{44})^{(9)},$$

$$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$$

$$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$$

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)}\left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[((\hat{P}_{13})^{(1)} + G_{14}^0) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)}\left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $(1 + (a_{16})^{(2)} t) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[((\hat{P}_{16})^{(2)} + G_{17}^0) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $(1 + (a_{20})^{(3)} t) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for G_{21}, $G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $(1 + (a_{24})^{(4)} t) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0) e^{-(\hat{M}_{24})^{(4)} t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left[\left((\hat{P}_{24})^{(4)} + G_{25}^0 \right) e^{\left(-\frac{(\hat{P}_{24})^{(4)} + G_{25}^0}{G_{25}^0} \right)} + (\hat{P}_{24})^{(4)} \right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $(1 + (a_{28})^{(5)} t) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $(1 + (a_{32})^{(6)} t) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176

From which it follows that $(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(c) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right] ds_{(36)} =$ $\left(1+(a_{36})^{(7)}t\right)G_{37}^0 + \frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$	178
From which it follows that $(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)}\left(G_{41}^0+(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right] ds_{(40)} =$ $\left(1+(a_{40})^{(8)}t\right)G_{41}^0 + \frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	180
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0 + \int_0^t \left[(a_{44})^{(9)}\left(G_{45}^0+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right] ds_{(44)} =$ $\left(1+(a_{44})^{(9)}t\right)G_{45}^0 + \frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$	
From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$	

(G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for $G_{45}, G_{46}, T_{44}, T_{45}, T_{46}$	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)} + ((\hat{P}_{13})^{(1)} + G_j^0)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[((\hat{Q}_{13})^{(1)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{13})^{(1)}\right] \leq (\hat{Q}_{13})^{(1)}$	184
In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left((G^{(1)}, T^{(1)}), (G^{(2)}, T^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{13})^{(1)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{13})^{(1)}t}\}$	185
Indeed if we denote **Definition of** $\tilde{G}, \tilde{T}$: $(\tilde{G}, \tilde{T}) = \mathcal{A}^{(1)}(G, T)$ It results $\lvert\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{13})^{(1)} \lvert G_{14}^{(1)} - G_{14}^{(2)}\rvert e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}}\, ds_{(13)} +$ $\int_0^t \{(a'_{13})^{(1)} \lvert G_{13}^{(1)} - G_{13}^{(2)}\rvert e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{-(\hat{M}_{13})^{(1)}s_{(13)}} +$ $(a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) \lvert G_{13}^{(1)} - G_{13}^{(2)}\rvert e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}} +$ $G_{13}^{(2)} \lvert (a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) - (a''_{13})^{(1)}(T_{14}^{(2)}, s_{(13)})\rvert\ e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}}\} ds_{(13)}$ Where $s_{(13)}$ represents integrand that is integrated over the interval $[0, t]$ From the hypotheses it follows	
$\lvert G^{(1)} - G^{(2)}\rvert e^{-(\hat{M}_{13})^{(1)}t} \leq$ $\frac{1}{(\hat{M}_{13})^{(1)}}\left((a_{13})^{(1)} + (a'_{13})^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}\right) d\left((G^{(1)}, T^{(1)}; G^{(2)}, T^{(2)})\right)$	186

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	
Remark 1: The fact that we supposed $(a''_{13})^{(1)}$ and $(b''_{13})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ *and* $(\widehat{Q}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(1)}$ and $(b''_i)^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 2: There does not exist any t where $G_i\,(t) = 0$ *and* $T_i\,(t) = 0$ From 19 to 24 it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t\{(a'_i)^{(1)}-(a''_i)^{(1)}(T_{14}(s_{(13)}),s_{(13)})\}ds_{(13)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{\left(-(b'_i)^{(1)}t\right)} > 0 \quad \text{for } t > 0$	
Definition of $\left((\widehat{M}_{13})^{(1)}\right)_1, \left((\widehat{M}_{13})^{(1)}\right)_2$ *and* $\left((\widehat{M}_{13})^{(1)}\right)_3$: **Remark 3:** if G_{13} is bounded, the same property have also G_{14} *and* G_{15} . indeed if $G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \leq \left((\widehat{M}_{13})^{(1)}\right)_1 - (a'_{14})^{(1)}G_{14}$ and by integrating $G_{14} \leq \left((\widehat{M}_{13})^{(1)}\right)_2 = G_{14}^0 + 2(a_{14})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_1/(a'_{14})^{(1)}$ In the same way , one can obtain $G_{15} \leq \left((\widehat{M}_{13})^{(1)}\right)_3 = G_{15}^0 + 2(a_{15})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_2/(a'_{15})^{(1)}$ If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.	187
Remark 4: If G_{13} *is* bounded, from below, the same property holds for G_{14} *and* G_{15} . The proof is analogous with the preceding one. An analogous property is true if G_{14} is bounded from below.	188
Remark 5: If T_{13} is bounded from below and $\lim_{t\to\infty}((b''_i)^{(1)}\,(G(t),t)) = (b'_{14})^{(1)}$ then $T_{14} \to \infty$. **Definition of** $(m)^{(1)}$ and ε_1 : Indeed let t_1 be so that for $t > t_1$ $(b_{14})^{(1)} - (b''_i)^{(1)}(G(t),t) < \varepsilon_1, T_{13}\,(t) > (m)^{(1)}$	189
Then $\frac{dT_{14}}{dt} \geq (a_{14})^{(1)}(m)^{(1)} - \varepsilon_1 T_{14}$ which leads to $T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{\varepsilon_1}\right)(1 - e^{-\varepsilon_1 t}) + T_{14}^0 e^{-\varepsilon_1 t}$ If we take t such that $e^{-\varepsilon_1 t} = \frac{1}{2}$ it results	

$T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{2}\right)$, $t = log\frac{2}{\varepsilon_1}$ By taking now ε_1 sufficiently small one sees that T_{14} is unbounded. The same property holds for T_{15} if $\lim_{t\to\infty}(b''_{15})^{(1)}(G(t),t) = (b'_{15})^{(1)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	
It is now sufficient to take $\frac{(a_i)^{(2)}}{(\widehat{M}_{16})^{(2)}}$, $\frac{(b_i)^{(2)}}{(\widehat{M}_{16})^{(2)}} < 1$ and to choose $(\widehat{P}_{16})^{(2)}$ *and* $(\widehat{Q}_{16})^{(2)}$ large to have	190
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Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(7)}((G_{39})(t),t)) = (b_{37}^{'})^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i^{''})^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$	264
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$\int_0^t \{(a_{40}^{'})^{(8)} \left|G_{40}^{(1)}-G_{40}^{(2)}\right| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} +$
$(a_{40}^{''})^{(8)} \left(T_{41}^{(1)}, s_{(40)}\right) \left|G_{40}^{(1)}-G_{40}^{(2)}\right| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} +$
$G_{40}^{(2)} |(a_{40}^{''})^{(8)} \left(T_{41}^{(1)}, s_{(40)}\right) - (a_{40}^{''})^{(8)} \left(T_{41}^{(2)}, s_{(40)}\right)| \; e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} \} ds_{(40)}$

Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ 272

From the hypotheses it follows

$\left|(G_{43})^{(1)}-(G_{43})^{(2)}\right| e^{-(\widehat{M}_{40})^{(8)} t} \leq$ 273
$\frac{1}{(\widehat{M}_{40})^{(8)}} \left((a_{40})^{(8)} + (a_{40}^{'})^{(8)} + (\widehat{A}_{40})^{(8)} + (\widehat{P}_{40})^{(8)} (\widehat{k}_{40})^{(8)}\right) d\left(\left((G_{43})^{(1)}, (T_{43})^{(1)}; \; (G_{43})^{(2)}, (T_{43})^{(2)}\right)\right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

<u>Remark 36:</u> The fact that we supposed $(a_{40}^{''})^{(8)}$ and $(b_{40}^{''})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)} e^{(\widehat{M}_{40})^{(8)} t}$ *and* $(\widehat{Q}_{40})^{(8)} e^{(\widehat{M}_{40})^{(8)} t}$ respectively of $\mathbb{R}_+$. 274

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(8)}$ and $(b_i^{''})^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

<u>Remark 37</u> There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ 275

it results

$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(8)} - (a_i^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$

$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(8)} t)} > 0$ for $\mathrm{t} > 0$

<u>Definition of</u> $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: 276

<u>Remark 38:</u> if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if

$G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}^{'})^{(8)} G_{41}$ and by integrating

$G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)} \left((\widehat{M}_{40})^{(8)}\right)_1 / (a_{41}^{'})^{(8)}$

In the same way , one can obtain

$G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)} \left((\widehat{M}_{40})^{(8)}\right)_2 / (a_{42}^{'})^{(8)}$

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right) = \sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})} : (\widetilde{(G_{47})},\widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}),(T_{47}))$ It results	

$$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$$
$$\int_0^t \{(a_{44}')^{(9)} |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$$
$$(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$$
$$G_{44}^{(2)} |(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a_{44}'')^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}| e^{-(\widehat{M}_{44})^{(9)} t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)} \right) d \left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)} \right) \right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)} \right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)} \right)_1, \left((\widehat{M}_{44})^{(9)} \right)_2$ *and* $\left((\widehat{M}_{44})^{(9)} \right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)} \right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$$G_{45} \leq \left((\widehat{M}_{44})^{(9)} \right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)} \right)_1 / (a_{45}')^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq \left((\widehat{M}_{44})^{(9)} \right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)} \right)_2 / (a_{46}')^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t),t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t),t) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14},t) + (a_{14}^{''})^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$

Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: 281

By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: 282

By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- 283

If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by
$(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if \ (\nu_0)^{(1)} < (\nu_1)^{(1)}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$,

and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq$ $\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}] + G_{15}^0 e^{-(a_{15}')^{(1)}t})$	286
$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}\big((G_{19}), t\big) - (b''_{17})^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\big(u^{(2)}\big)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \; \boldsymbol{if} \; (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if} \; (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \; \boldsymbol{if} \; (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if} \; (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}, \; \boldsymbol{if} \; (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^{0}e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^{0}e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}}G_{16}^{0}e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}}G_{16}^{0}e^{(S_1)^{(2)}t}$	311
$(\frac{(a_{18})^{(2)}G_{16}^{0}}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t}-e^{-(S_2)^{(2)}t}\right]+G_{18}^{0}e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq$ $\frac{(a_{18})^{(2)}G_{16}^{0}}{(m_2)^{(2)}((S_1)^{(2)}-(a'_{18})^{(2)})}[e^{(S_1)^{(2)}t}-e^{-(a'_{18})^{(2)}t}]+G_{18}^{0}e^{-(a'_{18})^{(2)}t})$	312
$\boxed{T_{16}^{0}e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^{0}e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}}T_{16}^{0}e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}}T_{16}^{0}e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^{0}}{(\mu_1)^{(2)}((R_1)^{(2)}-(b'_{18})^{(2)})}\left[e^{(R_1)^{(2)}t}-e^{-(b'_{18})^{(2)}t}\right]+T_{18}^{0}e^{-(b'_{18})^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)}T_{16}^{0}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t}-e^{-(R_2)^{(2)}t}\right]+T_{18}^{0}e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)},(S_2)^{(2)},(R_1)^{(2)},(R_2)^{(2)}$:-	316
Where $(S_1)^{(2)}=(a_{16})^{(2)}(m_2)^{(2)}-(a'_{16})^{(2)}$ $(S_2)^{(2)}=(a_{18})^{(2)}-(p_{18})^{(2)}$	317
$(R_1)^{(2)}=(b_{16})^{(2)}(\mu_2)^{(1)}-(b'_{16})^{(2)}$ $(R_2)^{(2)}=(b'_{18})^{(2)}-(r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a'_{20})^{(3)}+(a'_{21})^{(3)}-(a''_{20})^{(3)}(T_{21},t)+(a''_{21})^{(3)}(T_{21},t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b'_{20})^{(3)}+(b'_{21})^{(3)}-(b''_{20})^{(3)}(G_{23},t)-(b''_{21})^{(3)}((G_{23}),t) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)},(\nu_2)^{(3)},(u_1)^{(3)},(u_2)^{(3)}$: By $(\nu_1)^{(3)}>0,(\nu_2)^{(3)}<0$ and respectively $(u_1)^{(3)}>0,(u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2+(\sigma_1)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}(u^{(3)})^2+(\tau_1)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
<u>Definition of</u> $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}\ , \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ , \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)},(S_2)^{(3)},(R_1)^{(3)},(R_2)^{(3)}$:- Where $(S_1)^{(3)}=(a_{20})^{(3)}(m_2)^{(3)}-(a'_{20})^{(3)}$ $(S_2)^{(3)}=(a_{22})^{(3)}-(p_{22})^{(3)}$ $(R_1)^{(3)}=(b_{20})^{(3)}(\mu_2)^{(3)}-(b'_{20})^{(3)}$ $(R_2)^{(3)}=(b'_{22})^{(3)}-(r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)},(\sigma_2)^{(4)},(\tau_1)^{(4)},(\tau_2)^{(4)}$: $(\sigma_1)^{(4)},(\sigma_2)^{(4)},(\tau_1)^{(4)},(\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)}\le-(a'_{24})^{(4)}+(a'_{25})^{(4)}-(a''_{24})^{(4)}(T_{25},t)+(a''_{25})^{(4)}(T_{25},t)\le-(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)}\le-(b'_{24})^{(4)}+(b'_{25})^{(4)}-(b''_{24})^{(4)}\big((G_{27}),t\big)-(b''_{25})^{(4)}\big((G_{27}),t\big)\le-(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)},(\nu_2)^{(4)},(u_1)^{(4)},(u_2)^{(4)},\nu^{(4)},u^{(4)}$: By $(\nu_1)^{(4)}>0,(\nu_2)^{(4)}<0$ and respectively $(u_1)^{(4)}>0,(u_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_1)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	329
Definition of $(\bar\nu_1)^{(4)},,(\bar\nu_2)^{(4)},(\bar u_1)^{(4)},(\bar u_2)^{(4)}$: By $(\bar\nu_1)^{(4)}>0,(\bar\nu_2)^{(4)}<0$ and respectively $(\bar u_1)^{(4)}>0,(\bar u_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_2)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(\nu_0)^{(4)},(m_1)^{(4)}=(\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)}<(\nu_1)^{(4)}$ $(m_2)^{(4)}=(\nu_1)^{(4)},(m_1)^{(4)}=(\bar\nu_1)^{(4)},\boldsymbol{if}\ (\nu_4)^{(4)}<(\nu_0)^{(4)}<(\bar\nu_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(\nu_4)^{(4)},(m_1)^{(4)}=(\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar\nu_4)^{(4)}<(\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar u_1)^{(4)},\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar u_1)^{(4)}$,	331

and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \textbf{if } (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b'_{26})^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b'_{26})^{(4)}t}\right] + T_{26}^0 e^{-(b'_{26})^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a'_{24})^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b'_{24})^{(4)}$ $(R_2)^{(4)} = (b'_{26})^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a'_{28})^{(5)} + (a'_{29})^{(5)} - (a''_{28})^{(5)}(T_{29}, t) + (a''_{29})^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b'_{28})^{(5)} + (b'_{29})^{(5)} - (b''_{28})^{(5)}((G_{31}), t) - (b''_{29})^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}, \ \boldsymbol{if}\ (\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}, \boldsymbol{if}\ (\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}, \ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}, \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \le G_{28}(t) \le G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \le G_{29}(t) \le \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \le G_{30}(t) \le\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b_{30}')^{(5)}t}\right]+T_{30}^0 e^{-(b_{30}')^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)},(S_2)^{(5)},(R_1)^{(5)},(R_2)^{(5)}$:- Where $(S_1)^{(5)}=(a_{28})^{(5)}(m_2)^{(5)}-(a_{28}')^{(5)}$ $(S_2)^{(5)}=(a_{30})^{(5)}-(p_{30})^{(5)}$ $(R_1)^{(5)}=(b_{28})^{(5)}(\mu_2)^{(5)}-(b_{28}')^{(5)}$ $(R_2)^{(5)}=(b_{30}')^{(5)}-(r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$: $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)}\leq-(a_{32}')^{(6)}+(a_{33}')^{(6)}-(a_{32}'')^{(6)}(T_{33},t)+(a_{33}'')^{(6)}(T_{33},t)\leq-(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)}\leq-(b_{32}')^{(6)}+(b_{33}')^{(6)}-(b_{32}'')^{(6)}\big((G_{35}),t\big)-(b_{33}'')^{(6)}\big((G_{35}),t\big)\leq-(\tau_1)^{(6)}$	349
Definition of $(\nu_1)^{(6)},(\nu_2)^{(6)},(u_1)^{(6)},(u_2)^{(6)},\nu^{(6)},u^{(6)}$: By $(\nu_1)^{(6)}>0,(\nu_2)^{(6)}<0$ and respectively $(u_1)^{(6)}>0,(u_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_1)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},\boldsymbol{if}\ (\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)},$ and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \ \boldsymbol{if} \ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)} \ , \boldsymbol{if} \ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b'_{34})^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b'_{34})^{(6)}t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
<u>**Definition of**</u> $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a'_{32})^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b'_{32})^{(6)}$ $(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$	359
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
<u>Definition of</u> $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
<u>Definition of</u> $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **<u>Definition of</u>** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)},\ \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}] + G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
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$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, $\boldsymbol{if}$ $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, $\boldsymbol{if}$ $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, $\boldsymbol{if}$ $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t}\Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

<u>Definition of</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}^{'})^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right) - (a_{14}^{''})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$

$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
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If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}^{'})^{(3)} - (a_{21}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21}, t)\right) - (a_{21}^{''})^{(3)}(T_{21}, t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>**Particular case :**</u>

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

<u>**Proof**</u> : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

<u>**Definition of**</u> $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)},\quad\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)},\quad\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}, \quad \boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}, \quad \boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}^{'})^{(8)} - (a_{41}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right) - (a_{41}^{''})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

Proof : From 99,20,44,22,23,44 we obtain 424 A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

<u>Definition of</u> $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

<u>Theorem</u> : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)}-(b_{13})^{(1)}(b_{14})^{(1)}>0$, $(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)}-(b_{13})^{(1)}(b_{14})^{(1)}-(b_{13}^{'})^{(1)}(r_{14})^{(1)}-(b_{14}^{'})^{(1)}(r_{14})^{(1)}+(r_{13})^{(1)}(r_{14})^{(1)}<0$ $with\ \ (p_{13})^{(1)},(r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)}-(a_{16})^{(2)}(a_{17})^{(2)}<0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)}-(a_{16})^{(2)}(a_{17})^{(2)}+(a_{16})^{(2)}(p_{16})^{(2)}+(a_{17}^{'})^{(2)}(p_{17})^{(2)}+(p_{16})^{(2)}(p_{17})^{(2)}>0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}>0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-(b_{16}^{'})^{(2)}(r_{17})^{(2)}-(b_{17}^{'})^{(2)}(r_{17})^{(2)}+(r_{16})^{(2)}(r_{17})^{(2)}<0$ $with\ \ (p_{16})^{(2)},(r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}<0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}+(a_{20})^{(3)}(p_{20})^{(3)}+(a_{21}^{'})^{(3)}(p_{21})^{(3)}+(p_{20})^{(3)}(p_{21})^{(3)}>0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}>0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-(b_{20}^{'})^{(3)}(r_{21})^{(3)}-(b_{21}^{'})^{(3)}(r_{21})^{(3)}+(r_{20})^{(3)}(r_{21})^{(3)}<0$ $with\ \ (p_{20})^{(3)},(r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}<0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}+(a_{24})^{(4)}(p_{24})^{(4)}+(a_{25}^{'})^{(4)}(p_{25})^{(4)}+(p_{24})^{(4)}(p_{25})^{(4)}>0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}>0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-(b_{24}^{'})^{(4)}(r_{25})^{(4)}-(b_{25}^{'})^{(4)}(r_{25})^{(4)}+(r_{24})^{(4)}(r_{25})^{(4)}<0$ $with\ \ (p_{24})^{(4)},(r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}<0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}+(a_{28})^{(5)}(p_{28})^{(5)}+(a_{29}^{'})^{(5)}(p_{29})^{(5)}+(p_{28})^{(5)}(p_{29})^{(5)}>0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}>0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b'_{44})^{(9)}(r_{45})^{(9)} - (b'_{45})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (c) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$

Definition and uniqueness of T_{14}^{*} :- 493

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]} \quad , \quad G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$$

Definition and uniqueness of T_{17}^{*} :- 494

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]} \quad , \quad G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$$ 495

Definition and uniqueness of T_{21}^{*} :- 496

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]} \quad , \quad G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$$

Definition and uniqueness of T_{25}^{*} :- 497

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]} \quad , \quad G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$$

Definition and uniqueness of T_{29}^{*} :- 498

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]} \quad , \quad G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$$

Definition and uniqueness of T_{33}^{*} :- 499

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]} \quad , \quad G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$$

Definition and uniqueness of T_{37}^* :- 500

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*) = 0$. With this value , we obtain from the three first equations

$$G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]} \quad , \quad G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$$

Definition and uniqueness of T_{41}^* :- 501

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations

$$G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]} \quad , \quad G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$$

Definition and uniqueness of T_{45}^* :- 501 A

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations

$$G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]} \quad , \quad G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$$

By the same argument, the equations admit solutions G_{13}, G_{14} if 502

$$\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$$

$$\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right] + (b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$$

Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$

By the same argument, the equations admit solutions G_{16}, G_{17} if 503

$$\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$$

$$\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right] + (b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$$

Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right] + (b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27}) + (b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right] + (b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*}) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31}) + (b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right] + (b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*}) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35}) + (b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right] + (b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^{*} such that $\varphi({G_{35}}^{*}) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39}) + (b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right] + (b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^{*} such that $\varphi({G_{39}}^{*}) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right]+(b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right]+(b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^* = \frac{(a_{24})^{(4)}G_{25}^*}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)}G_{25}^*}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)}T_{25}^*}{[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)}T_{25}^*}{[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*)=0$, T_{29}^* given by $f(T_{29}^*)=0$ and $G_{28}^* = \frac{(a_{28})^{(5)}G_{29}^*}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)}G_{29}^*}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)}T_{29}^*}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)}T_{29}^*}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*)=0$, T_{33}^* given by $f(T_{33}^*)=0$ and $G_{32}^* = \frac{(a_{32})^{(6)}G_{33}^*}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)}G_{33}^*}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)}T_{33}^*}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)}T_{33}^*}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*)=0$, T_{37}^* given by $f(T_{37}^*)=0$ and $G_{36}^* = \frac{(a_{36})^{(7)}G_{37}^*}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)}G_{37}^*}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)}T_{37}^*}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)}T_{37}^*}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*)=0$, T_{41}^* given by $f(T_{41}^*)=0$ and	523

$$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]} \quad , \quad G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$$

$$T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}')^{(8)} - (b_{40}'')^{(8)}((G_{43})^*)]} \quad , \quad T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}')^{(8)} - (b_{42}'')^{(8)}((G_{43})^*)]}$$

Finally we obtain the unique solution of 89 to 99 523 A

G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and

$$G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]} \quad , \quad G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$$

$$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]} \quad , \quad T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$$

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Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof:_Denote

__Definition of__ $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)} \quad , \frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$$

Then taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14} \qquad 525$$

$$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14} \qquad 526$$

$$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14} \qquad 527$$

$$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right) \qquad 528$$

$$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right) \qquad 529$$

$$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right) \qquad 530$$

ASYMPTOTIC STABILITY ANALYSIS 531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$ 532

$$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$$ 533

taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$$ 534

$$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}')^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$$ 535

$$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}')^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$$ 536

$$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}')^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$$ 537

$$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}')^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$$ 538

$$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}')^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$$ 539

ASYMPTOTIC STABILITY ANALYSIS 540

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(3)}$ *and* $(b_i'')^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial (a_{21}'')^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i'')^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$$

Then taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}')^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$$ 541

$$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}')^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$$ 542

$$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}')^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$$ 543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b'_{20})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b'_{21})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^*\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b'_{22})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^*\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(4)}$ *and* $(b''_i)^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^*\ ) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b''_i)^{(5)}}{\partial G_j}(\ (G_{31})^*\ ) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt}=-\left((a_{28}')^{(5)}+(p_{28})^{(5)}\right)\mathbb{G}_{28}+(a_{28})^{(5)}\mathbb{G}_{29}-(q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt}=-\left((a_{29}')^{(5)}+(p_{29})^{(5)}\right)\mathbb{G}_{29}+(a_{29})^{(5)}\mathbb{G}_{28}-(q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt}=-\left((a_{30}')^{(5)}+(p_{30})^{(5)}\right)\mathbb{G}_{30}+(a_{30})^{(5)}\mathbb{G}_{29}-(q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt}=-\left((b_{28}')^{(5)}-(r_{28})^{(5)}\right)\mathbb{T}_{28}+(b_{28})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt}=-\left((b_{29}')^{(5)}-(r_{29})^{(5)}\right)\mathbb{T}_{29}+(b_{29})^{(5)}\mathbb{T}_{28}+\sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt}=-\left((b_{30}')^{(5)}-(r_{30})^{(5)}\right)\mathbb{T}_{30}+(b_{30})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad ,T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^{*})=(q_{33})^{(6)} \quad , \frac{\partial(b_i'')^{(6)}}{\partial G_j}(\,(G_{35})^{*}\,)=s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt}=-\left((a_{32}')^{(6)}+(p_{32})^{(6)}\right)\mathbb{G}_{32}+(a_{32})^{(6)}\mathbb{G}_{33}-(q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt}=-\left((a_{33}')^{(6)}+(p_{33})^{(6)}\right)\mathbb{G}_{33}+(a_{33})^{(6)}\mathbb{G}_{32}-(q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt}=-\left((a_{34}')^{(6)}+(p_{34})^{(6)}\right)\mathbb{G}_{34}+(a_{34})^{(6)}\mathbb{G}_{33}-(q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt}=-\left((b_{32}')^{(6)}-(r_{32})^{(6)}\right)\mathbb{T}_{32}+(b_{32})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt}=-\left((b_{33}')^{(6)}-(r_{33})^{(6)}\right)\mathbb{T}_{33}+(b_{33})^{(6)}\mathbb{T}_{32}+\sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt}=-\left((b_{34}')^{(6)}-(r_{34})^{(6)}\right)\mathbb{T}_{34}+(b_{34})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j} \left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G_{36}^* \mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G_{37}^* \mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G_{38}^* \mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T_{36}^* \mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T_{37}^* \mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T_{38}^* \mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}} (T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j} \left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G_{40}^* \mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G_{41}^* \mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_{+})$ then the above equilibrium point is asymptotically stable. **Proof: Denote**	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$

$+\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}G_{18}$

$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\Big(\big((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\big)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\Big)$ $\Big(\big((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\big)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\Big)$ $\Big(\big((\lambda)^{(3)}\big)^{2}+\big((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\big)(\lambda)^{(3)}\Big)$ $\Big(\big((\lambda)^{(3)}\big)^{2}+\big((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\big)(\lambda)^{(3)}\Big)$ $+\Big(\big((\lambda)^{(3)}\big)^{2}+\big((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\big)(\lambda)^{(3)}\Big)(q_{22})^{(3)}G_{22}$ $+\big((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\big)\big((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\big)$ $\Big(\big((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\big)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\Big)\}=0$ +	
$\big((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)}\big)\{\big((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)}\big)$ $\Big[\Big(\big((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\big)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\Big)\Big]$ $\Big(\big((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\big)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\Big)$ $+\Big(\big((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)}\big)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\Big)$ $\Big(\big((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\big)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\Big)$ $\Big(\big((\lambda)^{(4)}\big)^{2}+\big((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\big)(\lambda)^{(4)}\Big)$ $\Big(\big((\lambda)^{(4)}\big)^{2}+\big((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\big)(\lambda)^{(4)}\Big)$ $+\Big(\big((\lambda)^{(4)}\big)^{2}+\big((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\big)(\lambda)^{(4)}\Big)(q_{26})^{(4)}G_{26}$ $+\big((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\big)\big((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\big)$ $\Big(\big((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\big)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\Big)\}=0$ +	
$\big((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)}\big)\{\big((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)}\big)$ $\Big[\Big(\big((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\big)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\Big)\Big]$ $\Big(\big((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\big)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\Big)$	

$$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}')^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}')^{(7)}+(b_{37}')^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b_{42}')^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}')^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}')^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}')^{(8)}+(b_{41}')^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b_{46}')^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}')^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)}+(b'_{44})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T^*_{45}+(b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$$

$$+\left(\left((\lambda)^{(9)}+(a'_{45})^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G^*_{44}+(a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$$

$$\left(\left((\lambda)^{(9)}+(b'_{44})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T^*_{45}+(b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2+\left((a'_{44})^{(9)}+(a'_{45})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2+\left((b'_{44})^{(9)}+(b'_{45})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^2+\left((a'_{44})^{(9)}+(a'_{45})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a'_{44})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$$

$$\left(\left((\lambda)^{(9)}+(b'_{44})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T^*_{45}+(b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION FOUR

Quasinormal Spectrum And The Black Hole Membrane

INTRODUCTION—VARIABLES USED

Quasinormal spectrum and the black hole membrane paradigm A.O. Starinets

(1) The membrane paradigm approach to black hole physics introduces (eb) the notion of a stretched horizon as (=) a fictitious time-like surface endowed with (e&eb) physical characteristics such as (=) entropy, viscosity and electrical conductivity.
(2) Authors show that certain properties of the stretched horizons are encoded in (eb) the quasinormal spectrum of black holes.
(3) They compute analytically the lowest quasinormal frequency of (e) a vector-type perturbation for (e) a generic black hole with (e&eb) a translationally invariant horizon (black brane) in terms of (e&eb) the background metric components.
(4) The resulting dispersion relation is identical to (=) the one obtained in the membrane paradigm treatment of (e) the diffusion on stretched horizons.

(5) Combined with the Buchel-Liu universality theorem for (e) the membrane's diffusion coefficient, result means (eb) that in the long wavelength limit the black brane spectrum of (e) gravitational perturbations exhibits (eb) a universal, purely imaginary quasinormal frequency.

(6) In the context of gauge-gravity duality, this provides (eb) yet another (third) proof of the universality of (e) shear viscosity to entropy density ratio in theories with (e&eb) gravity duals. Subjects: High Energy Physics - Theory (hep-th) Journal reference: Phys.Lett.B670:442-445,2009 DOI: 10.1016/j.physletb.2008.11.028 Cite as: arXiv:0806.3797 [hep-th] (or arXiv:0806.3797v1 [hep-th] for this version)

NOTATION

Module One

The membrane paradigm approach to black hole physics introduces (eb) the notion of a stretched horizon as (=) a fictitious time-like surface endowed with (e&eb) physical characteristics such as (=) entropy, viscosity and electrical conductivity

G_{13} : Category one of **membrane paradigm approach to black hole physics;** notion of a stretched horizon as (=) a fictitious time-like surface endowed with (e&eb) physical characteristics such as (=) entropy, viscosity and electrical conductivity

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of notion of a stretched horizon as (=) a fictitious time-like surface endowed with (e&eb) physical characteristics such as (=) entropy, viscosity and electrical conductivity; **membrane paradigm approach to black hole physics**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

The membrane paradigm approach to black hole physics introduces the notion of a stretched horizon as (=) a fictitious time-like surface endowed with (e&eb) physical characteristics such as (=) entropy, viscosity and electrical conductivity

G_{16} : Category one of membrane paradigm approach to black hole physics introduces the notion of a stretched horizon

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of fictitious time-like surface endowed with (e&eb) physical characteristics such as (=) entropy, viscosity and electrical conductivity

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

The membrane paradigm approach to black hole physics introduces the notion of a stretched horizon as a fictitious time-like surface endowed with (e&eb) physical characteristics such as (=) entropy, viscosity and electrical conductivity

G_{20} : Category one of **membrane paradigm approach to black hole physics introduces the notion of a stretched horizon as a fictitious time-like surface;** physical characteristics such as entropy, viscosity and electrical conductivity

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of physical characteristics such as entropy, viscosity and electrical conductivity **;membrane paradigm approach to black hole physics introduces the notion of a stretched horizon as a fictitious time-like surface**

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

Authors show that certain properties of the stretched horizons are encoded in (eb) the quasinormal spectrum of black holes

G_{24} : Category one of **certain properties of the stretched horizons are encoded;** quasinormal spectrum of black holes

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of quasinormal spectrum of black holes **;certain properties of the stretched horizons are encoded**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

They compute analytically the lowest quasinormal frequency of (e) a vector-type perturbation for (e) a generic black hole with (e&eb) a translationally invariant horizon (black brane) in terms of (e&eb) the background metric components

G_{28} : Category one of vector-type perturbation for (e) a generic black hole with (e&eb) a translationally invariant horizon (black brane) in terms of (e&eb) the background metric components

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of lowest quasinormal frequency

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

They compute analytically the lowest quasinormal frequency of a vector-type perturbation for (e) a generic black hole with (e&eb) a translationally invariant horizon (black brane) in terms of (e&eb) the background metric components

G_{32} : Category one of generic black hole with (e&eb) a translationally invariant horizon (black brane) in terms of (e&eb) the background metric components

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of lowest quasinormal frequency of a vector-type perturbation

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

They compute analytically the lowest quasinormal frequency of a vector-type perturbation for a generic black hole with (e&eb) a translationally invariant horizon (black brane) in terms of (e&eb) the background metric components

G_{36} : Category one of **lowest quasinormal frequency of a vector-type perturbation for a generic black hole;** translationally invariant horizon (black brane) in terms of (e&eb) the background metric components

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of translationally invariant horizon (black brane) in terms of (e&eb) the background metric components **;lowest quasinormal frequency of a vector-type perturbation for a generic black hole**

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

They compute analytically the lowest quasinormal frequency of a vector-type perturbation for a generic black hole with a translationally invariant horizon (black brane) in terms of (e&eb) the background metric components

G_{40} : Category one of **lowest quasinormal frequency of a vector-type perturbation for a generic black hole with a translationally invariant horizon (black brane);** background metric components

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of background metric components; **lowest quasinormal frequency of a vector-type perturbation for a generic black hole with a translationally invariant horizon (black brane)**

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

The resulting dispersion relation is identical to (=) the one obtained in the membrane paradigm treatment of (e) the diffusion on stretched horizons

G_{44} : Category one of resulting dispersion relation

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of one obtained in the membrane paradigm treatment of (e) the diffusion on stretched horizons

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)} (T_{14}, t) \right] G_{13}$	1

$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}')^{(1)} - (b_{14}'')^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}'')^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}'')^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}')^{(2)} - (b_{16}'')^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}')^{(2)} - (b_{17}'')^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}')^{(2)} - (b_{18}'')^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}'')^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}'')^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}'')^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}'')^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23

$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\left[(b_{26}')^{(4)}-(b_{26}'')^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25},t)=$ **First augmentation factor**	
$-(b_{24}'')^{(4)}\left((G_{27}),t\right)=$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\left[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\left[(a_{29}')^{(5)}+(a_{29}'')^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt}=(a_{30})^{(5)}G_{29}-\left[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[(b_{28}')^{(5)}-(b_{28}'')^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[(b_{29}')^{(5)}-(b_{29}'')^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[(b_{30}')^{(5)}-(b_{30}'')^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}'')^{(5)}(T_{29},t)=$ **First augmentation factor**	
$-(b_{28}'')^{(5)}\left((G_{31}),t\right)=$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\left[(a_{33}')^{(6)}+(a_{33}'')^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\left[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\left[(b_{32}')^{(6)}-(b_{32}'')^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt}=(b_{33})^{(6)}T_{32}-\left[(b_{33}')^{(6)}-(b_{33}'')^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt}=(b_{34})^{(6)}T_{33}-\left[(b_{34}')^{(6)}-(b_{34}'')^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}'')^{(6)}(T_{33},t)=$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt}=(a_{36})^{(7)}G_{37}-\left[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt}=(a_{37})^{(7)}G_{36}-\left[(a_{37}')^{(7)}+(a_{37}'')^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt}=(a_{38})^{(7)}G_{37}-\left[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt}=(b_{36})^{(7)}T_{37}-\left[(b_{36}')^{(7)}-(b_{36}'')^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt}=(b_{37})^{(7)}T_{36}-\left[(b_{37}')^{(7)}-(b_{37}'')^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt}=(b_{38})^{(7)}T_{37}-\left[(b_{38}')^{(7)}-(b_{38}'')^{(7)}\left((G_{39}),t\right)\right]T_{38}$	*42*
$+(a_{36}'')^{(7)}(T_{37},t)=$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt}=(a_{40})^{(8)}G_{41}-\left[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41},t)\right]G_{40}$	*43*

$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}, t) \right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)} ((G_{43}), t) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)} ((G_{43}), t) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)} ((G_{43}), t) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)} (T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)} (T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)} (T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)} ((G_{47}), t) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)} ((G_{47}), t) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)} ((G_{47}), t) \right] T_{46}$	54
$+(a''_{44})^{(9)} (T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)} ((G_{47}), t) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)} (T_{14}, t)} \boxed{+(a''_{16})^{(2,2,)} (T_{17}, t)} \boxed{+(a''_{20})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a''_{28})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a''_{32})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a''_{36})^{(7,7)} (T_{37}, t)} \boxed{+(a''_{40})^{(8,8)} (T_{41}, t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{bmatrix} G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)} (T_{14}, t)} \boxed{+(a''_{17})^{(2,2,)} (T_{17}, t)} \boxed{+(a''_{21})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a''_{29})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a''_{33})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a''_{37})^{(7,7)} (T_{37}, t)} \boxed{+(a''_{41})^{(8,8)} (T_{41}, t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)} (T_{14}, t)} \boxed{+(a''_{18})^{(2,2,)} (T_{17}, t)} \boxed{+(a''_{22})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a''_{30})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a''_{34})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a''_{38})^{(7,7)} (T_{37}, t)} \boxed{+(a''_{42})^{(8,8)} (T_{41}, t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a''_{13})^{(1)} (T_{14}, t)}$, $\boxed{(a''_{14})^{(1)} (T_{14}, t)}$, $\boxed{(a''_{15})^{(1)} (T_{14}, t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)} (T_{17}, t)}$, $\boxed{+(a''_{17})^{(2,2,)} (T_{17}, t)}$, $\boxed{+(a''_{18})^{(2,2,)} (T_{17}, t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)} (T_{21}, t)}$, $\boxed{+(a''_{21})^{(3,3,)} (T_{21}, t)}$, $\boxed{+(a''_{22})^{(3,3,)} (T_{21}, t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)} (T_{25}, t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)} (T_{25}, t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)} (T_{25}, t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)} (T_{29}, t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)} (T_{29}, t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)} (T_{29}, t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)} (T_{33}, t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)} (T_{33}, t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)} (T_{33}, t)}$ are sixth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{38}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a_{40}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}'')^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\left[\begin{matrix}(b_{13}')^{(1)}\boxed{-(b_{13}'')^{(1)}(G,t)}\boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}\boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)}\boxed{-(b_{40}'')^{(8,8)}(G_{43},t)}\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{13}$	58
$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[\begin{matrix}(b_{14}')^{(1)}\boxed{-(b_{14}'')^{(1)}(G,t)}\boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}\boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)}\boxed{-(b_{41}'')^{(8,8)}(G_{43},t)}\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{14}$	59
$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[\begin{matrix}(b_{15}')^{(1)}\boxed{-(b_{15}'')^{(1)}(G,t)}\boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}\boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}\boxed{-(b_{42}'')^{(8,8)}(G_{43},t)}\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{15}$	*60*
Where $\boxed{-(b_{13}'')^{(1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{40}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{41}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{42}'')^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[\begin{matrix}(a_{16}')^{(2)}\boxed{+(a_{16}'')^{(2)}(T_{17},t)}\boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)}\boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)}\boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)}\boxed{+(a_{44}'')^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{16}$	*61*

$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category	

1,2 and 3

$-(b''_{20})^{(3,3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,)}(G_{23},t)$ are third detrition coefficients for category 1,2 and 3

$-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1,2 and 3

$-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1,2 and 3

$-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1,2 and 3

$-(b''_{36})^{(7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3

$-(b''_{40})^{(8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3

$-(b''_{44})^{(9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{20} \quad (67)$$

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21} \quad (68)$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22} \quad (69)$$

$+(a''_{20})^{(3)}(T_{21},t)$, $+(a''_{21})^{(3)}(T_{21},t)$, $+(a''_{22})^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3

$+(a''_{16})^{(2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3

$+(a''_{13})^{(1,1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3

$+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation

coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[\begin{matrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25}$$ 74

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$$ 75

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24}$$ 76

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25}$$ 77

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$$ 78

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients*

for category 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation	

coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{28} \quad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{30} \quad 84$$

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{32} \quad 85$$

$$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\begin{bmatrix}(a'_{33})^{(6)}\boxed{+(a''_{33})^{(6)}(T_{33},t)}\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{33}$$	86
$$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\begin{bmatrix}(a'_{34})^{(6)}\boxed{+(a''_{34})^{(6)}(T_{33},t)}\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{34}$$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\begin{bmatrix}(b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{32}$$	88
$$\frac{dT_{33}}{dt}=(b_{33})^{(6)}T_{32}-\begin{bmatrix}(b'_{33})^{(6)}\boxed{-(b''_{33})^{(6)}(G_{35},t)}\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{33}$$	89
$$\frac{dT_{34}}{dt}=(b_{34})^{(6)}T_{33}-\begin{bmatrix}(b'_{34})^{(6)}\boxed{-(b''_{34})^{(6)}(G_{35},t)}\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{34}$$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3	

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	*91*
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	*92*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	*93*
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{28}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b_{36}')^{(7)} \boxed{-(b_{36}'')^{(7)}(G_{39},t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b_{37}')^{(7)} \boxed{-(b_{37}'')^{(7)}(G_{39},t)} \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b_{38}')^{(7)} \boxed{-(b_{38}'')^{(7)}(G_{39},t)} \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b_{36}'')^{(7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$	

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b_{40}')^{(8)} \boxed{-(b_{40}'')^{(8)}(G_{43},t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \begin{bmatrix} (b_{41}')^{(8)} \boxed{-(b_{41}'')^{(8)}(G_{43},t)} \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \begin{bmatrix} (b_{42}')^{(8)} \boxed{-(b_{42}'')^{(8)}(G_{43},t)} \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b_{36}'')^{(7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} =$ $(b_{44})^{(9)} T_{45} -$	

$$\left[\begin{matrix} (b_{44}^{'})^{(9)} \boxed{-(b_{44}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$$(b_{45})^{(9)} T_{44} - \left[\begin{matrix} (b_{45}^{'})^{(9)} \boxed{-(b_{45}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$$(b_{46})^{(9)} T_{45} - \left[\begin{matrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3

Where we suppose

$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i, j = 13,14,15$ 97

The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(1)}, \ (r_i)^{(1)}$:

$(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\|(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14} - T_{14}'\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G - G'\|\|e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	

$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty} (a_i'')^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty} (b_i'')^{(2)}((G_{19}),t) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)} \lvert T_{17} - T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)} \lvert\lvert(G_{19}) - (G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i')^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$	112

The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (r_i)^{(3)}$: $(a_i'')^{(3)}(T_{21},t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t) \leq \ (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	
$lim_{T_2\to\infty}(a_i'')^{(3)}(T_{21},t) = (p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}(G_{23},t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}',t) - (a_i'')^{(3)}(T_{21},t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}',t) - (b_i'')^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and $(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}, i = 20,21,22$, satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded.	117

Definition of $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}\big((G_{27}),t\big) \leq\ (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(4)}\,(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i^{''})^{(4)}\big((G_{27}),t\big) =\ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	118
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}\big((G_{27}),t\big)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\big[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\big]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\,(a_i)^{(4)} + (a_i^{'})^{(4)} +\ (\hat{A}_{24})^{(4)} +\ (\hat{P}_{24})^{(4)}\,(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)} + (b_i^{'})^{(4)} +\ (\hat{B}_{24})^{(4)} +\ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded.	122

<u>Definition of</u> $(p_i)^{(5)}, \ (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t) \le (p_i)^{(5)} \le (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}\big((G_{31}),t\big) \le \ (r_i)^{(5)} \le (b_i^{'})^{(5)} \le (\hat{B}_{28})^{(5)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t) = \ (r_i)^{(5)}$ <u>Definition of</u> $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(5)}(T_{29}^{'},t) - (a_i^{''})^{(5)}(T_{29},t)\rvert \le (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}^{'}\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i^{''})^{(5)}((G_{31})^{'},t) - (b_i^{''})^{(5)}\big((G_{31}),t\big)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})^{'}\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and$(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $\big[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}\big]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}} \ , \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
<u>Definition of</u> $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and \ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i^{'})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)} + (a_i^{'})^{(5)} + \ (\hat{A}_{28})^{(5)} + \ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)} + (b_i^{'})^{(5)} + \ (\hat{B}_{28})^{(5)} + \ (\hat{Q}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i^{'})^{(6)}, (a_i^{''})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (b_i^{''})^{(6)} > 0, \quad i,j = 32,33,34$	127

The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, \ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \leq \ (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2 \to \infty} (a_i'')^{(6)} (T_{33}, t) = (p_i)^{(6)}$ $\lim_{G \to \infty} (b_i'')^{(6)} \left((G_{35}), t\right) = \ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert (a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t) \rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}' \rvert e^{-(\hat{M}_{32})^{(6)} t}$ $\lvert (b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}\left((G_{35}), t\right) \rvert < (\hat{k}_{32})^{(6)} \lvert\lvert (G_{35}) - (G_{35})' \rvert\lvert e^{-(\hat{M}_{32})^{(6)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and$(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}} [\ (a_i)^{(6)} + (a_i')^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}} [\ (b_i)^{(6)} + (b_i')^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	

(S) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (T) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39},t) \leq \ (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(U) $\lim_{T_2\to\infty} \ (a_i^{''})^{(7)} (T_{37},t) = (p_i)^{(7)}$ *(V)* $\lim_{G\to\infty} (b_i^{''})^{(7)} \left((G_{39}),t\right) = \ (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(7)}(T_{37}^{'},t) - (a_i^{''})^{(7)}(T_{37},t)\rvert \leq (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}^{'}\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i^{''})^{(7)}((G_{39})^{'},t) - (b_i^{''})^{(7)}\left((G_{39}),t\right)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})^{'}\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'},t)$ and $(a_i^{''})^{(7)}(T_{37},t)$. $(T_{37}^{'},t)$ and (T_{37},t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (W) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)},$ are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (X) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and \ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[\ (a_i)^{(7)} + (a_i^{'})^{(7)} + \ (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135

$\frac{1}{(\hat{M}_{36})^{(7)}}[\ (b_i)^{(7)} + (b_i^{'})^{(7)} + \ (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}] < 1$	
Where we suppose	
$(a_i)^{(8)}, (a_i^{'})^{(8)}, (a_i^{''})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (b_i^{''})^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i^{''})^{(8)}, (b_i^{''})^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, \ (r_i)^{(8)}$:	137
$(a_i^{''})^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i^{''})^{(8)}((G_{43}), t) \leq \ (r_i)^{(8)} \leq (b_i^{'})^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty} (a_i^{''})^{(8)}(T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty} (b_i^{''})^{(8)}\left((G_{43}), t\right) = \ (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\|(a_i^{''})^{(8)}(T_{41}^{'}, t) - (a_i^{''})^{(8)}(T_{41}, t)\| \leq (\hat{k}_{40})^{(8)}\|T_{41} - T_{41}^{'}\|e^{-(\hat{M}_{40})^{(8)}t}$	142
$\|(b_i^{''})^{(8)}((G_{43})^{'}, t) - (b_i^{''})^{(8)}\left((G_{43}), t\right)\| < (\hat{k}_{40})^{(8)}\|\|(G_{43}) - (G_{43})^{'}\|\|e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}^{'}, t)$ and $(a_i^{''})^{(8)}(T_{41}, t)$. $(T_{41}^{'}, t)$ and (T_{41}, t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i^{''})^{(8)}(T_{41}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i^{'})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}, i = 40,41,42,$	

Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i')^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)},\ (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t)\le(p_i)^{(9)}\le(\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t)\le(r_i)^{(9)}\le(b_i')^{(9)}\le(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t)=(r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)\rvert\le(\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}'\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)\rvert<(\hat{k}_{44})^{(9)}\lvert\lvert(G_{47})-(G_{47})'\rvert\lvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ ,\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with	

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0), T_i(0)$

$$G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t} \quad , \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t} \quad , \quad T_i(0) = T_i^0 > 0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t} \quad , \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t} \quad , \quad T_i(0) = T_i^0 > 0$$

Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 150

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 151

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 152

Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	

$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}')^{(1)} - (b_{13}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}')^{(1)} - (b_{14}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}')^{(1)} - (b_{15}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{16})^{(2)}, T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}')^{(2)} + a_{16}'')^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{16}(s_{(16)}) \right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}')^{(2)} + (a_{17}'')^{(2)} (T_{17}(s_{(16)}), s_{(17)}) \right) G_{17}(s_{(16)}) \right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}')^{(2)} + (a_{18}'')^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{18}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}')^{(2)} - (b_{16}'')^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{16}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}')^{(2)} - (b_{17}'')^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{17}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}')^{(2)} - (b_{18}'')^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{18}(s_{(16)}) \right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{20}(s_{(20)}) \right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{22}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{20}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{22}(s_{(20)}) \right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to$	

$\mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{28} \,)^{(5)} \, , T_i^0 \leq (\, \hat{Q}_{28} \,)^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{28} \,)^{(5)} e^{(\, \hat{M}_{28} \,)^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{28} \,)^{(5)} e^{(\, \hat{M}_{28} \,)^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i \, , \, T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} \, , T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	

$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 ,\ T_i(0) = T_i^0 ,\ G_i^0 \leq (\hat{P}_{36})^{(7)} , T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 ,\ T_i(0) = T_i^0 ,\ G_i^0 \leq (\hat{P}_{40})^{(8)} , T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \le (\hat{P}_{44})^{(9)},\ T_i^0 \le (\hat{Q}_{44})^{(9)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a'_{44})^{(9)} + a''_{44})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	

The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0 \right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0} \right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
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The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for G_{21}, G_{22}, T_{20}, T_{21}, T_{22}	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173

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From which it follows that $(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[((\hat{P}_{28})^{(5)}+G_{29}^0)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)}+(\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
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From which it follows that	

$(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0+\int_0^t\left[(a_{40})^{(8)}\left(G_{41}^0+(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right]ds_{(40)}=$ $\left(1+(a_{40})^{(8)}t\right)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	180
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41} , $G_{42}, T_{40}, T_{41}, T_{42}$	181
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From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45} , $G_{46}, T_{44}, T_{45}, T_{46}$	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)}+\left((\hat{P}_{13})^{(1)}+G_j^0\right)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{Q}_{13})^{(1)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{13})^{(1)}\right] \leq (\hat{Q}_{13})^{(1)}$	184
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The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left(\left(G^{(1)},T^{(1)}\right),\left(G^{(2)},T^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\widehat{M}_{13})^{(1)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\widehat{M}_{13})^{(1)}t}\}$	185
Indeed if we denote **Definition of** $\tilde{G},\tilde{T}$: $\left(\tilde{G},\tilde{T}\right)=\mathcal{A}^{(1)}(G,T)$ It results $\left\|\tilde{G}_{13}^{(1)}-\tilde{G}_i^{(2)}\right\|\leq\int_0^t(a_{13})^{(1)}\left\|G_{14}^{(1)}-G_{14}^{(2)}\right\|e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{(\widehat{M}_{13})^{(1)}s_{(13)}}\,ds_{(13)}+$ $\int_0^t\{(a_{13}^{'})^{(1)}\left\|G_{13}^{(1)}-G_{13}^{(2)}\right\|e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}+$ $(a_{13}^{''})^{(1)}\left(T_{14}^{(1)},s_{(13)}\right)\left\|G_{13}^{(1)}-G_{13}^{(2)}\right\|e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{(\widehat{M}_{13})^{(1)}s_{(13)}}+$ $G_{13}^{(2)}\|(a_{13}^{''})^{(1)}\left(T_{14}^{(1)},s_{(13)}\right)-(a_{13}^{''})^{(1)}\left(T_{14}^{(2)},s_{(13)}\right)\|\ e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{(\widehat{M}_{13})^{(1)}s_{(13)}}\}ds_{(13)}$ Where $s_{(13)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	
$\left\|G^{(1)}-G^{(2)}\right\|e^{-(\widehat{M}_{13})^{(1)}t}\leq$ $\frac{1}{(\widehat{M}_{13})^{(1)}}\left((a_{13})^{(1)}+\ (a_{13}^{'})^{(1)}+(\widehat{A}_{13})^{(1)}+(\widehat{P}_{13})^{(1)}(\widehat{k}_{13})^{(1)}\right)d\left(\left(G^{(1)},T^{(1)};\ G^{(2)},T^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	186
<u>Remark 1:</u> The fact that we supposed $(a_{13}^{''})^{(1)}$ and $(b_{13}^{''})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ *and* $(\widehat{Q}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(1)}$ and $(b_i^{''})^{(1)}, i=13,14,15$ depend only on T_{14} and respectively on $G(\mathit{and\ not\ on\ \ t})$ and hypothesis can replaced by a usual Lipschitz condition.	
<u>Remark 2:</u> There does not exist any t where $G_i\,(t)=0$ *and* $T_i\,(t)=0$ From 19 to 24 it results $G_i\,(t)\geq G_i^0e^{\left[-\int_0^t\{(a_i^{'})^{(1)}-(a_i^{''})^{(1)}(T_{14}(s_{(13)}),s_{(13)})\}ds_{(13)}\right]}\geq0$ $T_i\,(t)\geq T_i^0e^{\left(-(b_i^{'})^{(1)}t\right)}>0\ \ \text{for } \mathrm{t}>0$	

Definition of $\left((\widehat{M}_{13})^{(1)}\right)_1, \left((\widehat{M}_{13})^{(1)}\right)_2$ *and* $\left((\widehat{M}_{13})^{(1)}\right)_3$: **Remark 3:** if G_{13} is bounded, the same property have also G_{14} *and* G_{15} . indeed if $G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \leq \left((\widehat{M}_{13})^{(1)}\right)_1 - (a_{14}^{'})^{(1)}G_{14}$ and by integrating $G_{14} \leq \left((\widehat{M}_{13})^{(1)}\right)_2 = G_{14}^0 + 2(a_{14})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_1/(a_{14}^{'})^{(1)}$ In the same way , one can obtain $G_{15} \leq \left((\widehat{M}_{13})^{(1)}\right)_3 = G_{15}^0 + 2(a_{15})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_2/(a_{15}^{'})^{(1)}$ If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.	187
Remark 4: If G_{13} *is* bounded, from below, the same property holds for G_{14} *and* G_{15} . The proof is analogous with the preceding one. An analogous property is true if G_{14} is bounded from below.	188
Remark 5: If T_{13} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(1)}(G(t),t)) = (b_{14}^{'})^{(1)}$ then $T_{14} \to \infty$. **Definition of** $(m)^{(1)}$ and ε_1 : Indeed let t_1 be so that for $t > t_1$ $(b_{14})^{(1)} - (b_i^{''})^{(1)}(G(t),t) < \varepsilon_1, T_{13}(t) > (m)^{(1)}$	189
Then $\frac{dT_{14}}{dt} \geq (a_{14})^{(1)}(m)^{(1)} - \varepsilon_1 T_{14}$ which leads to $T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{\varepsilon_1}\right)(1 - e^{-\varepsilon_1 t}) + T_{14}^0 e^{-\varepsilon_1 t}$ If we take t such that $e^{-\varepsilon_1 t} = \frac{1}{2}$ it results $T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{2}\right), \quad t = log\frac{2}{\varepsilon_1}$ By taking now ε_1 sufficiently small one sees that T_{14} is unbounded. The same property holds for T_{15} if $\lim_{t\to\infty}(b_{15}^{''})^{(1)}(G(t),t) = (b_{15}^{'})^{(1)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	
It is now sufficient to take $\frac{(a_i)^{(2)}}{(\widehat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\widehat{M}_{16})^{(2)}} < 1$ and to choose $(\widehat{P}_{16})^{(2)}$ *and* $(\widehat{Q}_{16})^{(2)}$ large to have	190
$\frac{(a_i)^{(2)}}{(\widehat{M}_{16})^{(2)}}\left[(\widehat{P}_{16})^{(2)} + ((\widehat{P}_{16})^{(2)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{16})^{(2)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{16})^{(2)}$	191
$\frac{(b_i)^{(2)}}{(\widehat{M}_{16})^{(2)}}\left[((\widehat{Q}_{16})^{(2)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{16})^{(2)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{16})^{(2)}\right] \leq (\widehat{Q}_{16})^{(2)}$	192
In order that the operator $\mathcal{A}^{(2)}$ transforms the space of sextuples of functions G_i , T_i satisfying	193

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The operator $\mathcal{A}^{(2)}$ is a contraction with respect to the metric $d\left(\left((G_{19})^{(1)},(T_{19})^{(1)}\right),\left((G_{19})^{(2)},(T_{19})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\widehat{M}_{16})^{(2)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\widehat{M}_{16})^{(2)}t}\}$	194
Indeed if we denote **Definition of** $\widetilde{G_{19}},\widetilde{T_{19}}$: $\left(\widetilde{G_{19}},\widetilde{T_{19}}\right)=\mathcal{A}^{(2)}(G_{19},T_{19})$	195
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The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) = \sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}), (T_{47})\right)$ It results $\lvert\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{44})^{(9)} \lvert G_{45}^{(1)} - G_{45}^{(2)}\rvert e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{(\hat{M}_{44})^{(9)}s_{(44)}} ds_{(44)} + \int_0^t \{(a_{44}')^{(9)} \lvert G_{44}^{(1)} - G_{44}^{(2)}\rvert e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{-(\hat{M}_{44})^{(9)}s_{(44)}} + (a_{44}'')^{(9)}(T_{45}^{(1)}, s_{(44)}) \lvert G_{44}^{(1)} - G_{44}^{(2)}\rvert e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{(\hat{M}_{44})^{(9)}s_{(44)}} + G_{44}^{(2)} \lvert (a_{44}'')^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a_{44}'')^{(9)}(T_{45}^{(2)}, s_{(44)})\rvert\ e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{(\hat{M}_{44})^{(9)}s_{(44)}}\} ds_{(44)}$ Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$ From the hypotheses on 45,46,47,28 and 29 it follows	
$\lvert (G_{47})^{(1)} - G^{(2)}\rvert e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right) d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows	
Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by	

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G, t) - (b_{14}^{''})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)},\ if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)},\ if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}] + G_{15}^0 e^{-(a_{15}')^{(1)}t})$	286
$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\left((G_{19}), t\right) - (b_{17}'')^{(2)}\left((G_{19}), t\right) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300

roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})}\left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a'_{18})^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a'_{18})^{(2)}t}\right] + G_{18}^0 e^{-(a'_{18})^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b'_{18})^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b'_{18})^{(2)}t}\right] + T_{18}^0 e^{-(b'_{18})^{(2)}t} \leq T_{18}(t) \leq$	315

$\frac{(a_{18})^{(2)}T_{16}^{0}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t}-e^{-(R_2)^{(2)}t}\right]+T_{18}^{0}e^{-(R_2)^{(2)}t}$	
Definition of $(S_1)^{(2)},(S_2)^{(2)},(R_1)^{(2)},(R_2)^{(2)}$:-	316
Where $(S_1)^{(2)}=(a_{16})^{(2)}(m_2)^{(2)}-(a_{16}')^{(2)}$ $(S_2)^{(2)}=(a_{18})^{(2)}-(p_{18})^{(2)}$	317
$(R_1)^{(2)}=(b_{16})^{(2)}(\mu_2)^{(1)}-(b_{16}')^{(2)}$ $(R_2)^{(2)}=(b_{18}')^{(2)}-(r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)}\leq-(a_{20}')^{(3)}+(a_{21}')^{(3)}-(a_{20}'')^{(3)}(T_{21},t)+(a_{21}'')^{(3)}(T_{21},t)\leq-(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)}\leq-(b_{20}')^{(3)}+(b_{21}')^{(3)}-(b_{20}'')^{(3)}(G_{23},t)-(b_{21}'')^{(3)}((G_{23}),t)\leq-(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)},(\nu_2)^{(3)},(u_1)^{(3)},(u_2)^{(3)}$: By $(\nu_1)^{(3)}>0,(\nu_2)^{(3)}<0$ and respectively $(u_1)^{(3)}>0,(u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_1)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_1)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$ and By $(\bar{\nu}_1)^{(3)}>0,(\bar{\nu}_2)^{(3)}<0$ and respectively $(\bar{u}_1)^{(3)}>0,(\bar{u}_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_2)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_2)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$	320
Definition of $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$ by $(m_2)^{(3)}=(\nu_0)^{(3)},(m_1)^{(3)}=(\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)}<(\nu_1)^{(3)}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\bar{\nu}_1)^{(3)},\boldsymbol{if}\ (\nu_1)^{(3)}<(\nu_0)^{(3)}<(\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)}=\frac{G_{20}^{0}}{G_{21}^{0}}}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)}<(\nu_0)^{(3)}$	321

and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ ,\boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
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$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

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Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)}+(a_{29}')^{(5)}-(a_{28}'')^{(5)}(T_{29},t)+(a_{29}'')^{(5)}(T_{29},t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)}+(b_{29}')^{(5)}-(b_{28}'')^{(5)}((G_{31}),t)-(b_{29}'')^{(5)}((G_{31}),t) \leq -(\tau_1)^{(5)}$	338
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$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
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roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
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$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^0e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)},(S_2)^{(7)},(R_1)^{(7)},(R_2)^{(7)}$:- Where $(S_1)^{(7)}=(a_{36})^{(7)}(m_2)^{(7)}-(a_{36}^{'})^{(7)}$ $(S_2)^{(7)}=(a_{38})^{(7)}-(p_{38})^{(7)}$ $(R_1)^{(7)}=(b_{36})^{(7)}(\mu_2)^{(7)}-(b_{36}^{'})^{(7)}$ $(R_2)^{(7)}=(b_{38}^{'})^{(7)}-(r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)},(\sigma_2)^{(8)},(\tau_1)^{(8)},(\tau_2)^{(8)}$: $(\sigma_1)^{(8)},(\sigma_2)^{(8)},(\tau_1)^{(8)},(\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)}\le-(a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}-(a_{40}^{''})^{(8)}(T_{41},t)+(a_{41}^{''})^{(8)}(T_{41},t)\le-(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)}\le-(b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(b_{40}^{''})^{(8)}\big((G_{43}),t\big)-(b_{41}^{''})^{(8)}\big((G_{43}),t\big)\le-(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)},(\nu_2)^{(8)},(u_1)^{(8)},(u_2)^{(8)},\nu^{(8)},u^{(8)}$: By $(\nu_1)^{(8)}>0,(\nu_2)^{(8)}<0$ and respectively $(u_1)^{(8)}>0,(u_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_1)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_1)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ and	372
Definition of $(\bar{\nu}_1)^{(8)},,(\bar{\nu}_2)^{(8)},(\bar{u}_1)^{(8)},(\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)}>0,(\bar{\nu}_2)^{(8)}<0$ and respectively $(\bar{u}_1)^{(8)}>0,(\bar{u}_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_2)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_2)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ **Definition of** $(m_1)^{(8)},(m_2)^{(8)},(\mu_1)^{(8)},(\mu_2)^{(8)},(\nu_0)^{(8)}$:- If we define $(m_1)^{(8)},(m_2)^{(8)},(\mu_1)^{(8)},(\mu_2)^{(8)}$ by $(m_2)^{(8)}=(\nu_0)^{(8)},(m_1)^{(8)}=(\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)}<(\nu_1)^{(8)}$	

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, $\boldsymbol{if}$ $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}$ $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)})} \left[e^{((S_1)^{(8)} - (p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t} \right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq \right.$ $\left. \frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)} - (a_{42}')^{(8)})} [e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}] + G_{42}^0 e^{-(a_{42}')^{(8)}t} \right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)} - (b_{42}')^{(8)})} \left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t} \right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)} + (r_{40})^{(8)} + (R_2)^{(8)})} \left[e^{((R_1)^{(8)} + (r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t} \right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$

$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	
($\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$ $\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a'_{46})^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a'_{46})^{(9)}t}] + G_{46}^0 e^{-(a'_{46})^{(9)}t})$	
$T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b'_{46})^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b'_{46})^{(9)}t}\right] + T_{46}^0 e^{-(b'_{46})^{(9)}t} \leq T_{46}(t) \leq$ $\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a'_{44})^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b'_{44})^{(9)}$ $(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$	
Proof : From global equations we obtain $\frac{dv^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)v^{(1)} - (a_{14})^{(1)}v^{(1)}$ **Definition of** $v^{(1)}$:- $v^{(1)} = \frac{G_{13}}{G_{14}}$ It follows $-\left((a_{14})^{(1)}(v^{(1)})^2 + (\sigma_2)^{(1)}v^{(1)} - (a_{13})^{(1)}\right) \leq \frac{dv^{(1)}}{dt} \leq -\left((a_{14})^{(1)}(v^{(1)})^2 + (\sigma_1)^{(1)}v^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-	383

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	386

Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}$, $\boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390
In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393

If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}, \quad \boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}, \quad \boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$$

Definition of $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{20}'')^{(3)} = (a_{21}'')^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b_{20}'')^{(3)} = (b_{21}'')^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
Proof : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a_{24}')^{(4)} - (a_{25}')^{(4)} + (a_{24}'')^{(4)}(T_{25},t)\right) - (a_{25}'')^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **Definition of** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	405
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)},\quad\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)},\quad\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**
Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$**, and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \le \frac{d\nu^{(7)}}{dt} \le -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \ge \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \le \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \le \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \le \nu^{(7)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right) t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right) t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right) t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right) t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have
Definition of $\nu^{(8)}(t)$:-

$$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}, \quad \boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$$

In a completely analogous way, we obtain
Definition of $u^{(8)}(t)$:-

$$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}, \quad \boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

Proof : From 99,20,44,22,23,44 we obtain 424 A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \le \frac{d\nu^{(9)}}{dt} \le -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \ge \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \le \nu^{(9)}(t) \le (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \le \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \le \nu^{(9)}(t) \le (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \le \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \le \nu^{(9)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \le (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}'')^{(9)} = (a_{45}'')^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}'')^{(9)} = (b_{45}'')^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$ if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i'')^{(1)} and\ (b_i'')^{(1)}$ are independent on t , and the conditions with the notations

$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}')^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$,

$(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}')^{(1)}(r_{14})^{(1)} - (b_{14}')^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$

$with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system

Theorem : If $(a_i'')^{(2)} and\ (b_i'')^{(2)}$ are independent on t , and the conditions with the notations 426

$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$ 427

$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}')^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$ 428

$(b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$, 429

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)},(r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)},(r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)},(r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)},(r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

$with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (d) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)} G_{17}}{[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)} G_{17}}{[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$	499
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right]+(b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right]+(b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{25} such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{29} such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{33} such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{37} such that $\varphi(G_{39}{}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b'_{16})^{(2)} - (b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b'_{18})^{(2)} - (b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b'_{24})^{(4)} - (b''_{24})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b'_{26})^{(4)} - (b''_{26})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^{*} given by $\varphi((G_{31})^{*})=0$, T_{29}^{*} given by $f(T_{29}^{*})=0$ and $G_{28}^{*}=\frac{(a_{28})^{(5)}G_{29}^{*}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*}=\frac{(a_{30})^{(5)}G_{29}^{*}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	
$T_{28}^{*}=\frac{(b_{28})^{(5)}T_{29}^{*}}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*}=\frac{(b_{30})^{(5)}T_{29}^{*}}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*})=0$, T_{33}^{*} given by $f(T_{33}^{*})=0$ and $G_{32}^{*}=\frac{(a_{32})^{(6)}G_{33}^{*}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*}=\frac{(a_{34})^{(6)}G_{33}^{*}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*}=\frac{(b_{32})^{(6)}T_{33}^{*}}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^{*})]}$, $T_{34}^{*}=\frac{(b_{34})^{(6)}T_{33}^{*}}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*})=0$, T_{37}^{*} given by $f(T_{37}^{*})=0$ and $G_{36}^{*}=\frac{(a_{36})^{(7)}G_{37}^{*}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}^{*}=\frac{(a_{38})^{(7)}G_{37}^{*}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$ $T_{36}^{*}=\frac{(b_{36})^{(7)}T_{37}^{*}}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^{*})]}$, $T_{38}^{*}=\frac{(b_{38})^{(7)}T_{37}^{*}}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*})=0$, T_{41}^{*} given by $f(T_{41}^{*})=0$ and $G_{40}^{*}=\frac{(a_{40})^{(8)}G_{41}^{*}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42}^{*}=\frac{(a_{42})^{(8)}G_{41}^{*}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$ $T_{40}^{*}=\frac{(b_{40})^{(8)}T_{41}^{*}}{[(b_{40}^{'})^{(8)}-(b_{40}^{''})^{(8)}((G_{43})^{*})]}$, $T_{42}^{*}=\frac{(b_{42})^{(8)}T_{41}^{*}}{[(b_{42}^{'})^{(8)}-(b_{42}^{''})^{(8)}((G_{43})^{*})]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^{*} given by $\varphi((G_{47})^{*})=0$, T_{45}^{*} given by $f(T_{45}^{*})=0$ and $G_{44}^{*}=\frac{(a_{44})^{(9)}G_{45}^{*}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46}^{*}=\frac{(a_{46})^{(9)}G_{45}^{*}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	523 A

$T_{44}^{*}=\frac{(b_{44})^{(9)}T_{45}^{*}}{[(b_{44}^{'})^{(9)}-(b_{44}^{''})^{(9)}((G_{47})^{*})]}$, $T_{46}^{*}=\frac{(b_{46})^{(9)}T_{45}^{*}}{[(b_{46}^{'})^{(9)}-(b_{46}^{''})^{(9)}((G_{47})^{*})]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i$, $T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^{*}) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^{*}) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)}G_{13}^{*}\mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)}G_{14}^{*}\mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)}G_{15}^{*}\mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)}T_{13}^{*}\mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)}T_{14}^{*}\mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)}T_{15}^{*}\mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^{*} + \mathbb{G}_i$, $T_i = T_i^{*} + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^{*}) = (q_{17})^{(2)}$, $\frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^{*}) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^{*}\mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*}) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T^*_{25}) = (q_{25})^{(4)} \ , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G^*_{24}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G^*_{25}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G^*_{26}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T^*_{24}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T^*_{25}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T^*_{26}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 5:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	555
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T^*_{29}) = (q_{29})^{(5)} \ , \frac{\partial (b''_i)^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G^*_{28}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G^*_{29}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G^*_{30}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T^*_{28}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T^*_{29}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T^*_{30}\mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \ , \ \frac{\partial (b_i'')^{(6)}}{\partial G_j}(\ (G_{35})^*\ ) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \ , \ \frac{\partial (b_i'')^{(7)}}{\partial G_j}(\ (G_{39})^{**}\ ) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^{*}\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^{*}\mathbb{G}_{j}\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^{*}\mathbb{G}_{j}\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^{*}\mathbb{G}_{j}\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}(\,(G_{43})^*\,) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^{*}\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^{*}\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}')^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}')^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}')^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(9)}$ *and* $(b_i'')^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i'')^{(9)}}{\partial G_j}(\,(G_{47})^*\,) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^*\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^*\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^*\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^*\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^*\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^*\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}')^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^* + (b_{14})^{(1)}s_{(13),(13)}T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$ $+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$ +	

$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

+

$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$

$+\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$

+

$((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(((\lambda)^{(4)})^{2}+((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^{2}+((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)})(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^{2}+((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(((\lambda)^{(5)})^{2}+((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^{2}+((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)})(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^{2}+((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$ +	

$$((\lambda)^{(6)} + (b'_{34})^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a'_{34})^{(6)} + (p_{34})^{(6)})$$

$$\left[\left(((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)})(q_{33})^{(6)}G^*_{33} + (a_{33})^{(6)}(q_{32})^{(6)}G^*_{32}\right)\right]$$

$$\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)})s_{(33),(33)}T^*_{33} + (b_{33})^{(6)}s_{(32),(33)}T^*_{33}\right)$$

$$+\left(((\lambda)^{(6)} + (a'_{33})^{(6)} + (p_{33})^{(6)})(q_{32})^{(6)}G^*_{32} + (a_{32})^{(6)}(q_{33})^{(6)}G^*_{33}\right)$$

$$\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)})s_{(33),(32)}T^*_{33} + (b_{33})^{(6)}s_{(32),(32)}T^*_{32}\right)$$

$$\left(((\lambda)^{(6)})^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(((\lambda)^{(6)})^2 + \left((b'_{32})^{(6)} + (b'_{33})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(((\lambda)^{(6)})^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)})\left((a_{34})^{(6)}(q_{33})^{(6)}G^*_{33} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G^*_{32}\right)$$

$$\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)})s_{(33),(34)}T^*_{33} + (b_{33})^{(6)}s_{(32),(34)}T^*_{32}\right)\} = 0$$

$+$

$$((\lambda)^{(7)} + (b'_{38})^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a'_{38})^{(7)} + (p_{38})^{(7)})$$

$$\left[\left(((\lambda)^{(7)} + (a'_{36})^{(7)} + (p_{36})^{(7)})(q_{37})^{(7)}G^*_{37} + (a_{37})^{(7)}(q_{36})^{(7)}G^*_{36}\right)\right]$$

$$\left(((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)})s_{(37),(37)}T^*_{37} + (b_{37})^{(7)}s_{(36),(37)}T^*_{37}\right)$$

$$+\left(((\lambda)^{(7)} + (a'_{37})^{(7)} + (p_{37})^{(7)})(q_{36})^{(7)}G^*_{36} + (a_{36})^{(7)}(q_{37})^{(7)}G^*_{37}\right)$$

$$\left(((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)})s_{(37),(36)}T^*_{37} + (b_{37})^{(7)}s_{(36),(36)}T^*_{36}\right)$$

$$\left(((\lambda)^{(7)})^2 + \left((a'_{36})^{(7)} + (a'_{37})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(((\lambda)^{(7)})^2 + \left((b'_{36})^{(7)} + (b'_{37})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(((\lambda)^{(7)})^2 + \left((a'_{36})^{(7)} + (a'_{37})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+((\lambda)^{(7)} + (a'_{36})^{(7)} + (p_{36})^{(7)})\left((a_{38})^{(7)}(q_{37})^{(7)}G^*_{37} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G^*_{36}\right)$$

$$\left(((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)})s_{(37),(38)}T^*_{37} + (b_{37})^{(7)}s_{(36),(38)}T^*_{36}\right)\} = 0$$

+

$$((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(((\lambda)^{(8)})^{2} + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(((\lambda)^{(8)})^{2} + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(((\lambda)^{(8)})^{2} + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$$

+

$$((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(((\lambda)^{(9)})^{2} + \left((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(((\lambda)^{(9)})^{2} + \left((b_{44}^{'})^{(9)} + (b_{45}^{'})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(((\lambda)^{(9)})^{2} + \left((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\} = 0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.	

SECTION FIVE

Black Hole Membrane Paradigm

INTRODUCTION—VARIABLES USED

Quasinormal spectrum and the black hole membrane paradigm A.O. Starinets

(1) The resulting dispersion relation is identical to (=) the one obtained in the membrane paradigm treatment of (e) the diffusion on stretched horizons.
(2) Combined with the Buchel-Liu universality theorem for (e) the membrane's diffusion coefficient, result means (eb) that in the long wavelength limit the black brane spectrum of (e) gravitational perturbations exhibits (eb) a universal, purely imaginary quasinormal frequency.
(3) In the context of gauge-gravity duality, this provides (eb) yet another (third) proof of the universality of (e) shear viscosity to entropy density ratio in theories with (e&eb) gravity duals. Subjects: High Energy Physics - Theory (hep-th) Journal reference: Phys.Lett.B670:442-445,2009 DOI: 10.1016/j.physletb.2008.11.028 Cite as: arXiv:0806.3797 [hep-th] (or arXiv:0806.3797v1 [hep-th] for this version)

NOTATION

Module One

The resulting dispersion relation is identical to the one obtained in the membrane paradigm treatment of (e) the diffusion on stretched horizons

G_{13} : Category one of **dispersion relation is identical to the one obtained in the membrane paradigm treatment;** diffusion on stretched horizons

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of diffusion on stretched horizons **;dispersion relation is identical to the one obtained in the membrane paradigm treatment**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Combined with the Buchel-Liu universality theorem for the membrane's diffusion coefficient, result means (eb) that in the long wavelength limit the black brane spectrum of (e) gravitational perturbations exhibits (eb) a universal, purely imaginary quasinormal frequency

G_{16} : Category one of Buchel-Liu universality theorem for the membrane's diffusion coefficient

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of long wavelength limit the black brane spectrum of (e) gravitational perturbations exhibits (eb) a universal, purely imaginary quasinormal frequency

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

Combined with the Buchel-Liu universality theorem for the membrane's diffusion coefficient, result means that in the long wavelength limit the black brane spectrum of (e) gravitational perturbations exhibits (eb) a universal, purely imaginary quasinormal frequency

G_{20} : Category one of **Buchel-Liu universality theorem for the membrane's diffusion coefficient, result means that in the long wavelength limit the black brane spectrum;** gravitational perturbations exhibits (eb) a universal, purely imaginary quasinormal frequency

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of gravitational perturbations exhibits (eb) a universal, purely imaginary quasinormal frequency; **Buchel-Liu universality theorem for the membrane's diffusion coefficient, result means that in the long wavelength limit the black brane spectrum**

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

Combined with the Buchel-Liu universality theorem for the membrane's diffusion coefficient, result means that in the long wavelength limit the black brane spectrum of gravitational perturbations exhibits (eb) a universal, purely imaginary quasinormal frequency

G_{24} : Category one of Buchel-Liu universality theorem for the membrane's diffusion coefficient, result means that in the long wavelength limit the black brane spectrum of gravitational perturbations

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of universal, purely imaginary quasinormal frequency

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

In the context of gauge-gravity duality, this provides (eb) yet another (third) proof of the universality of (e) shear viscosity to entropy density ratio in theories with (e&eb) gravity duals.

Subjects: High Energy Physics - Theory (hep-th) Journal reference: Phys.Lett.B670:442-445,2009 DOI: 10.1016/j.physletb.2008.11.028 Cite as: arXiv:0806.3797 [hep-th] (or arXiv:0806.3797v1 [hep-th] for this version)

G_{28} : Category one of gauge-gravity duality

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of yet another (third) proof of the universality of (e) shear viscosity to entropy density ratio in theories with (e&eb) gravity duals.

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

In the context of gauge-gravity duality, this provides yet another (third) proof of the universality of (e) shear viscosity to entropy density ratio in theories with (e&eb) gravity duals

G_{32} : Category one of shear viscosity to entropy density ratio in theories with (e&eb) gravity duals

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of context of gauge-gravity duality, this provides yet another (third) proof of the universality

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

In the context of gauge-gravity duality, this provides yet another (third) proof of the universality of shear viscosity to entropy density ratio in theories with (e&eb) gravity duals

G_{36} : Category one of **the context of gauge-gravity duality, this provides yet another (third) proof of the universality of shear viscosity;** theories with (e&eb) gravity duals

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of theories with (e&eb) gravity duals **;the context of gauge-gravity duality, this provides yet another (third) proof of the universality of shear viscosity**

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

In the context of gauge-gravity duality, this provides yet another (third) proof of the universality of shear viscosity to entropy density ratio in theories with (e&eb) gravity duals

G_{40} : Category one of **context of gauge-gravity duality, this provides yet another (third) proof of the universality of shear viscosity to entropy density ratio in theories;** gravity duals

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of gravity duals; **context of gauge-gravity duality, this provides yet another (third) proof of the universality of shear viscosity to entropy density ratio in theories**

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

Quasinormal spectrum and the black hole membrane paradigm

G_{44} : Category one of **Quasinormal spectrum;** black hole membrane paradigm

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of black hole membrane paradigm **;Quasinormal spectrum**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	

$(a_{13})^{(1)},(a_{14})^{(1)},(a_{15})^{(1)},(b_{13})^{(1)},(b_{14})^{(1)},(b_{15})^{(1)}$ $(a_{16})^{(2)},(a_{17})^{(2)},(a_{18})^{(2)}$ $(b_{16})^{(2)},(b_{17})^{(2)},(b_{18})^{(2)}$: $(a_{20})^{(3)},(a_{21})^{(3)},(a_{22})^{(3)}$, $(b_{20})^{(3)},(b_{21})^{(3)},(b_{22})^{(3)}$ $(a_{24})^{(4)},(a_{25})^{(4)},(a_{26})^{(4)},(b_{24})^{(4)},(b_{25})^{(4)},(b_{26})^{(4)},(b_{28})^{(5)},(b_{29})^{(5)},(b_{30})^{(5)},(a_{28})^{(5)},(a_{29})^{(5)},(a_{30})^{(5)}$, $(a_{32})^{(6)},(a_{33})^{(6)},(a_{34})^{(6)},(b_{32})^{(6)},(b_{33})^{(6)},(b_{34})^{(6)}$ $(a_{36})^{(7)},(a_{37})^{(7)},(a_{38})^{(7)},(b_{36})^{(7)},(b_{37})^{(7)},(b_{38})^{(7)}$ $(a_{40})^{(8)},(a_{41})^{(8)},(a_{42})^{(8)},(b_{40})^{(8)},(b_{41})^{(8)},(b_{42})^{(8)}$ $(a_{44})^{(9)},(a_{45})^{(9)},(a_{46})^{(9)},(b_{44})^{(9)},(b_{45})^{(9)},(b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)},(a'_{14})^{(1)},(a'_{15})^{(1)},(b'_{13})^{(1)},(b'_{14})^{(1)},(b'_{15})^{(1)},(a'_{16})^{(2)},(a'_{17})^{(2)},(a'_{18})^{(2)}$, $(b'_{16})^{(2)},(b'_{17})^{(2)},(b'_{18})^{(2)}$ $,(a'_{20})^{(3)},(a'_{21})^{(3)},(a'_{22})^{(3)},(b'_{20})^{(3)},(b'_{21})^{(3)},(b'_{22})^{(3)}$ $(a'_{24})^{(4)},(a'_{25})^{(4)},(a'_{26})^{(4)},(b'_{24})^{(4)},(b'_{25})^{(4)},(b'_{26})^{(4)},(b'_{28})^{(5)},(b'_{29})^{(5)},(b'_{30})^{(5)}$ $(a'_{28})^{(5)},(a'_{29})^{(5)},(a'_{30})^{(5)}$, $(a'_{32})^{(6)},(a'_{33})^{(6)},(a'_{34})^{(6)},(b'_{32})^{(6)},(b'_{33})^{(6)},(b'_{34})^{(6)}$ $(a'_{36})^{(7)},(a'_{37})^{(7)},(a'_{38})^{(7)},(b'_{36})^{(7)},(b'_{37})^{(7)},(b'_{38})^{(7)}$, $(a'_{40})^{(8)},(a'_{41})^{(8)},(a'_{42})^{(8)},(b'_{40})^{(8)},(b'_{41})^{(8)},(b'_{42})^{(8)}$, $(a'_{44})^{(9)},(a'_{45})^{(9)},(a'_{46})^{(9)},(b'_{44})^{(9)},(b'_{45})^{(9)},(b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt}=(a_{13})^{(1)}G_{14}-\left[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt}=(a_{14})^{(1)}G_{13}-\left[(a'_{14})^{(1)}+(a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\left[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\left[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[(b'_{14})^{(1)}-(b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t)=$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t)=$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[(a'_{17})^{(2)}+(a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[(b'_{16})^{(2)}-(b''_{16})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[(b'_{17})^{(2)}-(b''_{17})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[(b'_{18})^{(2)}-(b''_{18})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t)=$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}),t\right)=$ First detritions factor	
Module Numbered Three	

The differential system of this model is now (Module numbered three)	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t)\right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t)\right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t)\right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t)\right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23},t)\right] T_{22}$	18
$+(a''_{20})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25},t)\right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25},t)\right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27}),t\right)\right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27}),t\right)\right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27}),t\right)\right] T_{26}$	24
$+(a''_{24})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29},t)\right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29},t)\right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\left((G_{31}),t\right)\right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\left((G_{31}),t\right)\right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\left((G_{31}),t\right)\right] T_{30}$	30
$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right] G_{33}$	32

$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33},t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}),t\right)\right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right] T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t)\right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t)\right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t)\right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}),t\right)\right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}),t\right)\right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}),t\right)\right] T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41},t)\right] G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}),t\right)\right] T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}),t\right)\right] T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}),t\right)\right] T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45},t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45},t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45},t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left((G_{47}),t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left((G_{47}),t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left((G_{47}),t\right)\right] T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	

$$\frac{dG_{13}}{dt}=(a_{13})^{(1)}G_{14}-\left[\begin{matrix}(a'_{13})^{(1)}\boxed{+(a''_{13})^{(1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{13}$$ 55

$$\frac{dG_{14}}{dt}=(a_{14})^{(1)}G_{13}-\left[\begin{matrix}(a'_{14})^{(1)}\boxed{+(a''_{14})^{(1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{14}$$ 56

$$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\left[\begin{matrix}(a'_{15})^{(1)}\boxed{+(a''_{15})^{(1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{15}$$ 57

Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\left[\begin{matrix}(b'_{13})^{(1)}\boxed{-(b''_{13})^{(1)}(G,t)}\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{13}$$ 58

$$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[\begin{matrix}(b'_{14})^{(1)}\boxed{-(b''_{14})^{(1)}(G,t)}\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{14}$$ 59

$$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[\begin{matrix}(b'_{15})^{(1)}\boxed{-(b''_{15})^{(1)}(G,t)}\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{15}$$ 60

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\begin{bmatrix}(a'_{16})^{(2)}\boxed{+(a''_{16})^{(2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}\\\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}\\\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}\end{bmatrix}G_{16}$	*61*
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\begin{bmatrix}(a'_{17})^{(2)}\boxed{+(a''_{17})^{(2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}\\\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}\\\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}\end{bmatrix}G_{17}$	*62*
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\begin{bmatrix}(a'_{18})^{(2)}\boxed{+(a''_{18})^{(2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}\\\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}\\\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}\end{bmatrix}G_{18}$	*63*
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation	

coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3 $+(a''_{44})^{(9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9)}(T_{45},t)$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} -(b''_{16})^{(2)}(G_{19},t) -(b''_{13})^{(1,1,)}(G,t) -(b''_{20})^{(3,3,3,)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8)}(G_{43},t) -(b''_{44})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} -(b''_{17})^{(2)}(G_{19},t) -(b''_{14})^{(1,1,)}(G,t) -(b''_{21})^{(3,3,3,)}(G_{23},t) \\ -(b''_{25})^{(4,4,4,4,4)}(G_{27},t) -(b''_{29})^{(5,5,5,5,5)}(G_{31},t) -(b''_{33})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{37})^{(7,7,7)}(G_{39},t) -(b''_{41})^{(8,8,8)}(G_{43},t) -(b''_{45})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} -(b''_{18})^{(2)}(G_{19},t) -(b''_{15})^{(1,1,)}(G,t) -(b''_{22})^{(3,3,3,)}(G_{23},t) \\ -(b''_{26})^{(4,4,4,4,4)}(G_{27},t) -(b''_{30})^{(5,5,5,5,5)}(G_{31},t) -(b''_{34})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{38})^{(7,7,7)}(G_{39},t) -(b''_{42})^{(8,8,8)}(G_{43},t) -(b''_{46})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{18}$	66
where $-(b''_{16})^{(2)}(G_{19},t)$, $-(b''_{17})^{(2)}(G_{19},t)$, $-(b''_{18})^{(2)}(G_{19},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{13})^{(1,1,)}(G,t)$, $-(b''_{14})^{(1,1,)}(G,t)$, $-(b''_{15})^{(1,1,)}(G,t)$ are second detrition coefficients for category 1,2 and 3 $-(b''_{20})^{(3,3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,)}(G_{23},t)$ are third detrition coefficients for category 1,2 and 3 $-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1,2 and 3 $-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1,2 and 3 $-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1,2 and 3 $-(b''_{36})^{(7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3 $-(b''_{40})^{(8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3 $-(b''_{44})^{(9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3	

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \right] G_{20}$$ 67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \right] G_{21}$$ 68

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \right] G_{22}$$ 69

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \right] T_{20}$$ 70

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \right] T_{21}$$ 71

$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22}$	*72*
$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3* $\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24}$	*73*
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25}$	*74*
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$	*75*
$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1, 2\ \ 3$ $\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ $are\ second\ augmentation\ coefficient\ for\ category\ 1, 2\ and\ 3$ $\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category\ 1, 2\ and\ 3$	

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$

are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$

are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$

are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$

are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$

are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{28} \qquad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{29} \qquad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{30} \qquad 81$$

$Where$ $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ $are\ first\ augmentation\ coefficients\ for\ category$ $1, 2$ and 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ $are\ second\ augmentation\ coefficient\ for\ category$ $1, 2$ and 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category$ $1, 2$ and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{28} \qquad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{29} \qquad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{30}$$ 84

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{32}$$ 85

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{33}$$ 86

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{34}$$ 87

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation*

$coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}, \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}, \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32}$	*88*
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33}$	*89*
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34}$	*90*
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}, \boxed{-(b''_{33})^{(6)}(G_{35},t)}, \boxed{-(b''_{34})^{(6)}(G_{35},t)}$ $are\ first\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}, \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}, \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ $are\ second\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}, \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}, \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ $are\ third\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}, \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}, \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}, \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}, \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}, \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}, \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}, \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}, \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3	

$-(b_{40}'')^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{42}'')^{(8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2, and 3 $-(b_{46}'')^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b_{45}'')^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b_{44}'')^{(9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a_{36}')^{(7)} +(a_{36}'')^{(7)}(T_{37},t) +(a_{16}'')^{(2,2,2,2,2,2,2)}(T_{17},t) +(a_{20}'')^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a_{24}'')^{(4,4,4,4,4,4,4)}(T_{25},t) +(a_{28}'')^{(5,5,5,5,5,5,5)}(T_{29},t) +(a_{32}'')^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t) +(a_{40}'')^{(8,8,8,8,8,8,8,)}(T_{41},t) +(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a_{37}')^{(7)} +(a_{37}'')^{(7)}(T_{37},t) +(a_{17}'')^{(2,2,2,2,2,2,2)}(T_{17},t) +(a_{21}'')^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a_{25}'')^{(4,4,4,4,4,4,4)}(T_{25},t) +(a_{29}'')^{(5,5,5,5,5,5,5)}(T_{29},t) +(a_{33}'')^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t) +(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t) +(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{14}$	92
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a_{38}')^{(7)} +(a_{38}'')^{(7)}(T_{37},t) +(a_{18}'')^{(2,2,2,2,2,2,2)}(T_{17},t) +(a_{22}'')^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a_{26}'')^{(4,4,4,4,4,4,4)}(T_{25},t) +(a_{30}'')^{(5,5,5,5,5,5,5)}(T_{29},t) +(a_{34}'')^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a_{15}'')^{(1,1,1,1,1,1,1)}(T_{14},t) +(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t) +(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{15}$	93
Where $(a_{36}'')^{(7)}(T_{37},t)$, $(a_{37}'')^{(7)}(T_{37},t)$, $(a_{38}'')^{(7)}(T_{37},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a_{16}'')^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a_{17}'')^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a_{18}'')^{(2,2,2,2,2,2,2)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a_{20}'')^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a_{21}'')^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a_{22}'')^{(3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a_{24}'')^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a_{25}'')^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a_{26}'')^{(4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a_{28}'')^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a_{29}'')^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a_{30}'')^{(5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a_{32}'')^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a_{33}'')^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a_{34}'')^{(6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a_{15}'')^{(1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a_{40}'')^{(8,8,8,8,8,8,8,)}(T_{41},t)$ are eighth augmentation coefficient for 1,2,3 $+(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} =$	94

$$(b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$

$$\frac{dT_{37}}{dt} =$$

$$(b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{38}}{dt} =$$

$$(b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13} \quad (95)$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$,$\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$,$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$(b_{41})^{(8)}T_{40} - \begin{bmatrix} (b_{41}^{'})^{(8)} \boxed{-(b_{41}^{''})^{(8)}(G_{43},t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \begin{bmatrix} (b_{42}^{'})^{(8)} \boxed{-(b_{42}^{''})^{(8)}(G_{43},t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	
Where $\boxed{-(b_{36}^{''})^{(7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \begin{bmatrix} (a_{44}^{'})^{(9)} \boxed{+(a_{44}^{''})^{(9)}(T_{45},t)} \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13}$	96
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a_{45}^{'})^{(9)} \boxed{+(a_{45}^{''})^{(9)}(T_{45},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$	

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45} - \left[\begin{array}{ccc} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{array} \right] T_{15}$	
Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i^{''})^{(1)}(T_{14},t) \le (p_i)^{(1)} \le (\hat{A}_{13})^{(1)}$ $(b_i^{''})^{(1)}(G,t) \le \ (r_i)^{(1)} \le (b_i^{'})^{(1)} \le (\hat{B}_{13})^{(1)}$	97
$lim_{T_2 \to \infty} (a_i^{''})^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b_i^{''})^{(1)} (G,t) = \ (r_i)^{(1)}$ **<u>Definition of</u>** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\lvert (a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert (b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)}$, $(r_i)^{(1)},i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i')^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i')^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0,\quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}$, $(r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t)\leq(p_i)^{(2)}\leq\left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t)\leq (r_i)^{(2)}\leq(b_i')^{(2)}\leq(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}\left((G_{19}),t\right)= (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	

$\lvert(a_i^{''})^{(2)}(T_{17}^{'},t)-(a_i^{''})^{(2)}(T_{17},t)\rvert \le (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}^{'}\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i^{''})^{(2)}((G_{19})^{'},t)-(b_i^{''})^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})^{'}\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'},t)$ and $(a_i^{''})^{(2)}(T_{17},t)$. $(T_{17}^{'},t)$ and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i^{''})^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
<u>**Definition of**</u> $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i^{'})^{(2)},(b_i)^{(2)},(b_i^{'})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)}+(a_i^{'})^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\,(\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i^{'})^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i^{'})^{(3)},(a_i^{''})^{(3)},(b_i)^{(3)},(b_i^{'})^{(3)},(b_i^{''})^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i^{''})^{(3)},(b_i^{''})^{(3)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(3)},\ (\mathrm{r_i})^{(3)}$: $(a_i^{''})^{(3)}(T_{21},t)\le(p_i)^{(3)}\le(\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23},t)\le\ (r_i)^{(3)}\le(b_i^{'})^{(3)}\le(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i^{''})^{(3)}\,(T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i^{''})^{(3)}\,(G_{23},t)=\ (r_i)^{(3)}$ <u>**Definition of**</u> $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}}$ are positive constants and $\boxed{i=20,21,22}$	113

They satisfy Lipschitz condition: $\lvert(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21}-T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i'')^{(3)}(G_{23}',t)-(b_i'')^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23}-G_{23}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
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Definition of $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}$, $\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)},(r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)}+(a_i')^{(3)}+(\hat{A}_{20})^{(3)}+(\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)}+(b_i')^{(3)}+(\hat{B}_{20})^{(3)}+(\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}]<1$	116
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$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)}>0, \quad i,j=24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t)=(r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},(r_i)^{(4)}$ are positive constants and $i=24,25,26$	118
They satisfy Lipschitz condition:	119

$\lvert (a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t) \rvert \leq (\hat{k}_{24})^{(4)} \lvert T_{25} - T_{25}^{'} \rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert (b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}((G_{27}),t) \rvert < (\hat{k}_{24})^{(4)} \lvert\lvert (G_{27}) - (G_{27})^{'} \rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
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Where we suppose	
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$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t) = \ (r_i)^{(5)}$ <u>**Definition of**</u> $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123

They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29}-T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31})-(G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
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Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}' \rvert e^{-(\hat{M}_{32})^{(6)} t}$ $\lvert(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}((G_{35}), t)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>**Definition of**</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and\ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}} [\, (a_i)^{(6)} + (a_i')^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)} \, (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}} [\ (b_i)^{(6)} + (b_i')^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(Y) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i, j = 36,37,38$ (Z) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq \ (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(AA) $\lim_{T_2 \to \infty} (a_i'')^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(BB)* $\lim_{G \to \infty} (b_i'')^{(7)} ((G_{39}), t) = \ (r_i)^{(7)}$	132

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	
They satisfy Lipschitz condition: $\|(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\| \leq (\hat{k}_{36})^{(7)} \|T_{37} - T_{37}'\| e^{-(\hat{M}_{36})^{(7)} t}$ $\|(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\| < (\hat{k}_{36})^{(7)} \|\|(G_{39}) - (G_{39})'\|\| e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)} \right]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (CC) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
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The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
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$(b_i^{''})^{(8)}((G_{43}),t) \leq \ (r_i)^{(8)} \leq (b_i^{'})^{(8)} \leq (\ \hat{B}_{40}\ )^{(8)}$	139
$\lim_{T_2\to\infty} (a_i^{''})^{(8)}\ (T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty} (b_i^{''})^{(8)} \left((G_{43}),t\right) = \ (r_i)^{(8)}$	141
Definition of $(\ \hat{A}_{40}\ )^{(8)}, (\ \hat{B}_{40}\ )^{(8)}$: Where $\boxed{(\ \hat{A}_{40}\ )^{(8)}, (\ \hat{B}_{40}\ )^{(8)}, (p_i)^{(8)},\ \ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'},t) - (a_i^{''})^{(8)}(T_{41},t)\rvert \leq (\ \hat{k}_{40}\ )^{(8)}\lvert T_{41} - \ T_{41}^{'}\rvert e^{-(\ \hat{M}_{40}\ )^{(8)}t}$	142
$\lvert(b_i^{''})^{(8)}((G_{43})^{'},t) - (b_i^{''})^{(8)}\left((G_{43}),t\right)\rvert < (\ \hat{k}_{40}\ )^{(8)}\lvert\lvert(G_{43}) - (G_{43})^{'}\rvert\rvert e^{-(\ \hat{M}_{40}\ )^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}^{'},t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. $(T_{41}^{'},t)$ and (T_{41},t) are points belonging to the interval $\left[(\ \hat{k}_{40}\ )^{(8)}, (\ \hat{M}_{40}\ )^{(8)}\right]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\ \hat{M}_{40}\ )^{(8)} = 1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\ \hat{M}_{40}\ )^{(8)}, (\ \hat{k}_{40}\ )^{(8)}$:	
$(\ \hat{M}_{40}\ )^{(8)}, (\ \hat{k}_{40}\ )^{(8)},$ are positive constants	
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$\frac{1}{(\ \hat{M}_{40}\ )^{(8)}}[\ (a_i)^{(8)} + (a_i^{'})^{(8)} + \ \ (\ \hat{A}_{40}\ )^{(8)} + \ (\ \hat{P}_{40}\ )^{(8)}\ (\ \hat{k}_{40}\ )^{(8)}] < 1$	145
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Where we suppose	
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The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$$(a_i^{''})^{(9)}(T_{45}, t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$$

$$(b_i^{''})^{(9)}(G_{47}, t) \leq \ (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$$

$$\lim_{T_2 \to \infty} (a_i^{''})^{(9)} (T_{45}, t) = (p_i)^{(9)}$$

$$\lim_{G \to \infty} (b_i^{''})^{(9)} (G_{47}, t) = \ (r_i)^{(9)}$$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$$|(a_i^{''})^{(9)}(T_{45}^{'}, t) - (a_i^{''})^{(9)}(T_{45}, t)| \leq (\hat{k}_{44})^{(9)} |T_{45} - T_{45}^{'}| e^{-(\hat{M}_{44})^{(9)} t}$$

$$|(b_i^{''})^{(9)}((G_{47})^{'}, t) - (b_i^{''})^{(9)}\big((G_{47}), t\big)| < (\hat{k}_{44})^{(9)} ||(G_{47}) - (G_{47})^{'}|| e^{-(\hat{M}_{44})^{(9)} t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'}, t)$ and $(a_i^{''})^{(9)}(T_{45}, t)$. $(T_{45}^{'}, t)$ and (T_{45}, t) are points belonging to the interval $\big[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\big]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}} [\ (a_i)^{(9)} + (a_i^{'})^{(9)} + \ (\hat{A}_{44})^{(9)} + \ (\hat{P}_{44})^{(9)} \ (\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}} [\ (b_i)^{(9)} + (b_i^{'})^{(9)} + \ (\hat{B}_{44})^{(9)} + \ (\hat{Q}_{44})^{(9)} \ (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13}\right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)$, $T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)$, $T_i(0)$:	153

$G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{13})^{(1)} , T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}')^{(1)} - (b_{13}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}')^{(1)} - (b_{14}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}')^{(1)} - (b_{15}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i\,,\, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \leq (\hat{P}_{16})^{(2)}\,, T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(16)}\right)\right) G_{16}\left(s_{(16)}\right)\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}\left(s_{(16)}\right) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(17)}\right)\right) G_{17}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(16)}\right)\right) G_{18}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{16}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}\left(s_{(16)}\right) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{17}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{18}\left(s_{(16)}\right)\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i\,,\, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \leq (\hat{P}_{20})^{(3)}\,, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{20}\left(s_{(20)}\right)\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}\left(s_{(20)}\right) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{21}\left(s_{(20)}\right)\right] ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$$

$$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$$

$$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$$

$$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$$

$$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$$

$$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$$

Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0 \,,\ T_i(0) = T_i^0 \,,\ G_i^0 \leq (\,\hat{P}_{32}\,)^{(6)} \,, T_i^0 \leq (\,\hat{Q}_{32}\,)^{(6)},$$

$$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{32}\,)^{(6)} e^{(\,\hat{M}_{32}\,)^{(6)} t}$$

$$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{32}\,)^{(6)} e^{(\,\hat{M}_{32}\,)^{(6)} t}$$

By 164

$$\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$$

$$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$$

$$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$$

$$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$$

$$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$$

$$\bar{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$$

Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0 \,, \; T_i(0) = T_i^0 \,, \; G_i^0 \leq (\hat{P}_{36})^{(7)} \,, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}')^{(7)} + a_{36}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}')^{(7)} - (b_{36}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}')^{(7)} - (b_{37}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}')^{(7)} - (b_{38}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i \,, T_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,, \; T_i(0) = T_i^0 \,, \; G_i^0 \leq (\hat{P}_{40})^{(8)} \,, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}')^{(8)} + a_{40}'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}')^{(8)} + (a_{41}'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
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From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
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$(1+(a_{40})^{(8)}t)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{P}_{40})^{(8)}+G_{41}^0)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
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From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t}\leq\frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{P}_{44})^{(9)}+G_{45}^0)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for $G_{45}, G_{46}, T_{44}, T_{45}, T_{46}$	
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$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[((\hat{Q}_{13})^{(1)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{13})^{(1)}\right]\leq(\hat{Q}_{13})^{(1)}$	184
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Indeed if we denote

Definition of $\tilde{G}, \tilde{T}$: $(\tilde{G}, \tilde{T}) = \mathcal{A}^{(1)}(G, T)$

It results

$|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}| \le \int_0^t (a_{13})^{(1)} |G_{14}^{(1)} - G_{14}^{(2)}| e^{-(\widetilde{M}_{13})^{(1)} s_{(13)}} e^{(\widetilde{M}_{13})^{(1)} s_{(13)}} \, ds_{(13)} +$

$\int_0^t \{(a'_{13})^{(1)} |G_{13}^{(1)} - G_{13}^{(2)}| e^{-(\widetilde{M}_{13})^{(1)} s_{(13)}} e^{-(\widetilde{M}_{13})^{(1)} s_{(13)}} +$

$(a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) |G_{13}^{(1)} - G_{13}^{(2)}| e^{-(\widetilde{M}_{13})^{(1)} s_{(13)}} e^{(\widetilde{M}_{13})^{(1)} s_{(13)}} +$

$G_{13}^{(2)} |(a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) - (a''_{13})^{(1)}(T_{14}^{(2)}, s_{(13)})| \; e^{-(\widetilde{M}_{13})^{(1)} s_{(13)}} e^{(\widetilde{M}_{13})^{(1)} s_{(13)}} \} ds_{(13)}$

Where $s_{(13)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses it follows

$|G^{(1)} - G^{(2)}| e^{-(\widetilde{M}_{13})^{(1)} t} \le$ 186

$\frac{1}{(\widetilde{M}_{13})^{(1)}} \left((a_{13})^{(1)} + (a'_{13})^{(1)} + (\widehat{A}_{13})^{(1)} + (\widehat{P}_{13})^{(1)} (\widehat{k}_{13})^{(1)} \right) d\left((G^{(1)}, T^{(1)}; \, G^{(2)}, T^{(2)}) \right)$

And analogous inequalities for G_i and T_i. Taking into account the hypothesis the result follows

Remark 1: The fact that we supposed $(a''_{13})^{(1)}$ and $(b''_{13})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{13})^{(1)} e^{(\widehat{M}_{13})^{(1)} t}$ and $(\widehat{Q}_{13})^{(1)} e^{(\widehat{M}_{13})^{(1)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(1)}$ and $(b''_i)^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(and \; not \; on \; t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i\,(t) = 0$ and $T_i\,(t) = 0$

From 19 to 24 it results

$G_i\,(t) \ge G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(1)} - (a''_i)^{(1)}(T_{14}(s_{(13)}), s_{(13)})\} ds_{(13)}\right]} \ge 0$

$T_i\,(t) \ge T_i^0 e^{(-(b'_i)^{(1)} t)} > 0 \quad \text{for } t > 0$

Definition of $\left((\widehat{M}_{13})^{(1)}\right)_1, \left((\widehat{M}_{13})^{(1)}\right)_2$ and $\left((\widehat{M}_{13})^{(1)}\right)_3$: 187

Remark 3: if G_{13} is bounded, the same property have also G_{14} and G_{15} . indeed if

$G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \le \left((\widehat{M}_{13})^{(1)}\right)_1 - (a'_{14})^{(1)} G_{14}$ and by integrating

$G_{14} \le \left((\widehat{M}_{13})^{(1)}\right)_2 = G_{14}^0 + 2(a_{14})^{(1)} \left((\widehat{M}_{13})^{(1)}\right)_1 / (a'_{14})^{(1)}$

In the same way , one can obtain $G_{15} \le \left((\widehat{M}_{13})^{(1)}\right)_3 = G_{15}^0 + 2(a_{15})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_2/(a_{15}^{'})^{(1)}$ If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.	
Remark 4: If G_{13} *is* bounded, from below, the same property holds for G_{14} *and* G_{15} . The proof is analogous with the preceding one. An analogous property is true if G_{14} is bounded from below.	188
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In order that the operator $\mathcal{A}^{(2)}$ transforms the space of sextuples of functions G_i ,T_i satisfying Equations into itself	193
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Indeed if we denote **Definition of** $\widetilde{G_{19}}, \widetilde{T_{19}}$: $\left(\widetilde{G_{19}}, \widetilde{T_{19}} \right) = \mathcal{A}^{(2)}(G_{19}, T_{19})$	195
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$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[(\hat{P}_{32})^{(6)} + ((\hat{P}_{32})^{(6)} + G_j^0)e^{-\left(\frac{(\hat{P}_{32})^{(6)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{32})^{(6)}$	245
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In order that the operator $\mathcal{A}^{(6)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	

The operator $\mathcal{A}^{(6)}$ is a contraction with respect to the metric 247

$d\left(\left((G_{35})^{(1)},(T_{35})^{(1)}\right),\left((G_{35})^{(2)},(T_{35})^{(2)}\right)\right)=$

$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\widehat{M}_{32})^{(6)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\widehat{M}_{32})^{(6)}t}\}$

Indeed if we denote

Definition of $\widetilde{(G_{35})},\widetilde{(T_{35})}$: $\left(\widetilde{(G_{35})},\widetilde{(T_{35})}\right)=\mathcal{A}^{(6)}\left((G_{35}),(T_{35})\right)$

It results

$\left|\tilde{G}_{32}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{32})^{(6)}\left|G_{33}^{(1)}-G_{33}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\,ds_{(32)}+$

$\int_0^t\{(a_{32}')^{(6)}\left|G_{32}^{(1)}-G_{32}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}+$

$(a_{32}'')^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)\left|G_{32}^{(1)}-G_{32}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}+$

$G_{32}^{(2)}|(a_{32}'')^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)-(a_{32}'')^{(6)}\left(T_{33}^{(2)},s_{(32)}\right)|\;e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$

Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses it follows

$\left|(G_{35})^{(1)}-(G_{35})^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}t}\leq$ 248

$\frac{1}{(\widehat{M}_{32})^{(6)}}\left((a_{32})^{(6)}+(a_{32}')^{(6)}+(\widehat{A}_{32})^{(6)}+(\widehat{P}_{32})^{(6)}(\widehat{k}_{32})^{(6)}\right)d\left(\left((G_{35})^{(1)},(T_{35})^{(1)};\;(G_{35})^{(2)},(T_{35})^{(2)}\right)\right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 26: The fact that we supposed $(a_{32}'')^{(6)}$ and $(b_{32}'')^{(6)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{32})^{(6)}e^{(\widehat{M}_{32})^{(6)}t}$ *and* $(\widehat{Q}_{32})^{(6)}e^{(\widehat{M}_{32})^{(6)}t}$ respectively of $\mathbb{R}_+$. 249

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(6)}$ and $(b_i'')^{(6)}, i=32,33,34$ depend only on T_{33} and respectively on (G_{35})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 27: There does not exist any t where $G_i\,(t)=0$ *and* $T_i\,(t)=0$ 250

it results

$G_i\,(t)\geq G_i^0 e^{\left[-\int_0^t\{(a_i')^{(6)}-(a_i'')^{(6)}(T_{33}(s_{(32)}),s_{(32)})\}ds_{(32)}\right]}\geq 0$

$T_i\,(t)\geq T_i^0 e^{\left(-(b_i')^{(6)}t\right)}>0\quad\text{for } \mathrm{t}>0$

Definition of $\left((\widehat{M}_{32})^{(6)}\right)_1, \left((\widehat{M}_{32})^{(6)}\right)_2$ *and* $\left((\widehat{M}_{32})^{(6)}\right)_3$: **Remark 28:** if G_{32} is bounded, the same property have also G_{33} *and* G_{34} . indeed if $G_{32} < (\widehat{M}_{32})^{(6)}$ it follows $\frac{dG_{33}}{dt} \leq \left((\widehat{M}_{32})^{(6)}\right)_1 - (a'_{33})^{(6)} G_{33}$ and by integrating $G_{33} \leq \left((\widehat{M}_{32})^{(6)}\right)_2 = G_{33}^0 + 2(a_{33})^{(6)}\left((\widehat{M}_{32})^{(6)}\right)_1/(a'_{33})^{(6)}$ In the same way , one can obtain $G_{34} \leq \left((\widehat{M}_{32})^{(6)}\right)_3 = G_{34}^0 + 2(a_{34})^{(6)}\left((\widehat{M}_{32})^{(6)}\right)_2/(a'_{34})^{(6)}$ If G_{33} *or* G_{34} is bounded, the same property follows for G_{32} , G_{34} and G_{32} , G_{33} respectively.	251
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In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
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Remark 32: There does not exist any t where $G_i\ (t)=0$ *and* $T_i\ (t)=0$ it results $G_i\ (t)\geq G_i^0 e^{\left[-\int_0^t\{(a_i')^{(7)}-(a_i'')^{(7)}(T_{37}(s_{(36)}),s_{(36)})\}ds_{(36)}\right]}\geq 0$	261

$T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(7)} t\right)} > 0$ for $t > 0$	
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$\frac{(a_i)^{(8)}}{(\widehat{M}_{40})^{(8)}}\left[(\widehat{P}_{40})^{(8)} + \left((\widehat{P}_{40})^{(8)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{40})^{(8)} + G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{40})^{(8)}$	267
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t}\}$	269
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Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
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it results

$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(8)} - (a_i^{''})^{(8)}(T_{41}(s_{(40)}),s_{(40)})\} ds_{(40)}\right]} \geq 0$

$T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(8)} t\right)} > 0$ for t > 0

Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: 276

Remark 38: if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if

$G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}^{'})^{(8)} G_{41}$ and by integrating

$G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1 / (a_{41}^{'})^{(8)}$

In the same way , one can obtain

$G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2 / (a_{42}^{'})^{(8)}$

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.

Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below. 277

Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(8)}((G_{43})(t),t)) = (b_{41}^{'})^{(8)}$ then $T_{41} \to \infty$. 278

Definition of $(m)^{(8)}$ and ε_8 :

Indeed let t_8 be so that for $t > t_8$

$(b_{41})^{(8)} - (b_i^{''})^{(8)}\left((G_{43})(t),t\right) < \varepsilon_8, T_{40}\,(t) > (m)^{(8)}$

Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to 279

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}^{''})^{(8)}\left((G_{43})(t), t(t), t\right) = (b_{42}^{'})^{(8)}$

It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + ((\widehat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[((\widehat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)}, (T_{47})^{(1)}), ((G_{47})^{(2)}, (T_{47})^{(2)})\right) = \sup_i\{\max_{t\in\mathbb{R}_+} |G_i^{(1)}(t) - G_i^{(2)}(t)|e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+} |T_i^{(1)}(t) - T_i^{(2)}(t)|e^{-(\widehat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}((G_{47}), (T_{47}))$

It results

$$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} e^{(\widehat{M}_{44})^{(9)}s_{(44)}} ds_{(44)} + \int_0^t \{(a'_{44})^{(9)}|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} + (a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)})|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} e^{(\widehat{M}_{44})^{(9)}s_{(44)}} + G_{44}^{(2)}|(a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a''_{44})^{(9)}(T_{45}^{(2)}, s_{(44)})| \ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\} ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}|e^{-(\widehat{M}_{44})^{(9)}t} \leq \frac{1}{(\widehat{M}_{44})^{(9)}}((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)})d\left(((G_{47})^{(1)}, (T_{47})^{(1)}; (G_{47})^{(2)}, (T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on t*) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}),s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2 \ and \left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also $G_{45} \ and \ G_{46}$. indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1/(a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2/(a_{46}^{'})^{(9)}$

If $G_{45} \ or \ G_{46}$ is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for $G_{45} \ and \ G_{46}$. The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}\left((G_{47})(t),t\right)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}\left((G_{47})(t),t\right) < \varepsilon_9, T_{44}\,(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}\left((G_{47})(t),t\right) = (b_{46}^{'})^{(9)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying

$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G,t) - (b''_{14})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
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and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)},if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $(u_0)^{(1)} = \frac{T^0_{13}}{T^0_{14}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)},if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G^0_{13}e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G^0_{13}e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}}G^0_{13}e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}}G^0_{13}e^{(S_1)^{(1)}t}$	285
$(\frac{(a_{15})^{(1)}G^0_{13}}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G^0_{15}e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq$ $\frac{(a_{15})^{(1)}G^0_{13}}{(m_2)^{(1)}((S_1)^{(1)}-(a'_{15})^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}] + G^0_{15}e^{-(a'_{15})^{(1)}t})$	286

$T_{13}^{0} e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^{0} e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^{0} e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^{0} e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^{0}}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})} \left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t} \right] + T_{15}^{0} e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^{0}}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})} \left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t} \right] + T_{15}^{0} e^{-(R_2)^{(1)}t}$	289
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$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\big((G_{19}), t\big) - (b_{17}'')^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
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of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\big(u^{(2)}\big)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)} t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)} t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})}\left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)} t}\right] + G_{18}^0 e^{-(S_2)^{(2)} t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a_{18}')^{(2)})}\left[e^{(S_1)^{(2)} t} - e^{-(a_{18}')^{(2)} t}\right] + G_{18}^0 e^{-(a_{18}')^{(2)} t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)} t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)} t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b_{18}')^{(2)})}\left[e^{(R_1)^{(2)} t} - e^{-(b_{18}')^{(2)} t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)} t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)} + (r_{16})^{(2)} + (R_2)^{(2)})}\left[e^{((R_1)^{(2)} + (r_{16})^{(2)})t} - e^{-(R_2)^{(2)} t}\right] + T_{18}^0 e^{-(R_2)^{(2)} t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)} (m_2)^{(2)} - (a_{16}')^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)}, \ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}, \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}, \ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$

Then the solution of global equations satisfies the inequalities

$G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$

$(p_i)^{(3)}$ is defined by equation

$$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$$ 323

$$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$$ 324

$$\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$$

$$T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$$ 325

$$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$$ 326

$$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$$ 327

$$\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$$

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- 328

Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$

$(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$

$(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$

$(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$

Behavior of the solutions of equation

Theorem: If we denote and define

Definition of $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$:

$(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying

$-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$

$-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}\big((G_{27}), t\big) - (b_{25}'')^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$

Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: 329

By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations

$(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_1)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	
Definition of $(\bar{\nu}_1)^{(4)},,(\bar{\nu}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)}>0,(\bar{\nu}_2)^{(4)}<0$ and respectively $(\bar{u}_1)^{(4)}>0,(\bar{u}_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_2)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(\nu_0)^{(4)},(m_1)^{(4)}=(\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)}<(\nu_1)^{(4)}$ $(m_2)^{(4)}=(\nu_1)^{(4)},(m_1)^{(4)}=(\bar{\nu}_1)^{(4)},\boldsymbol{if}\ (\nu_4)^{(4)}<(\nu_0)^{(4)}<(\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(\nu_4)^{(4)},(m_1)^{(4)}=(\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)}<(\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar{u}_1)^{(4)},\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)}=\frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(u_0)^{(4)},\boldsymbol{if}\ (\bar{u}_1)^{(4)}<(u_0)^{(4)}$ where $(u_1)^{(4)},(\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t}\leq G_{24}(t)\leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}}G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t}\leq G_{25}(t)\leq\frac{1}{(m_2)^{(4)}}G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t}-e^{-(S_2)^{(4)}t}\right]+G_{26}^0 e^{-(S_2)^{(4)}t}\leq G_{26}(t)\leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}}$	
$\frac{1}{(\mu_1)^{(4)}}T_{24}^0 e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq\frac{1}{(\mu_2)^{(4)}}T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t}\leq T_{26}(t)\leq$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}')^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}')^{(4)}$ $(R_2)^{(4)}=(b_{26}')^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\le-(a_{28}')^{(5)}+(a_{29}')^{(5)}-(a_{28}'')^{(5)}(T_{29},t)+(a_{29}'')^{(5)}(T_{29},t)\le-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\le-(b_{28}')^{(5)}+(b_{29}')^{(5)}-(b_{28}'')^{(5)}((G_{31}),t)-(b_{29}'')^{(5)}((G_{31}),t)\le-(\tau_1)^{(5)}$	338
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Definition of $(\bar{\nu}_1)^{(5)},,(\bar{\nu}_2)^{(5)},(\bar{u}_1)^{(5)},(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)}>0,(\bar{\nu}_2)^{(5)}<0$ and respectively $(\bar{u}_1)^{(5)}>0,(\bar{u}_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar{\nu}_1)^{(5)},\boldsymbol{if}\ (\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},$ ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)},$ ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)} t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)} t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})} \left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)} t} \right] + G_{30}^0 e^{-(S_2)^{(5)} t} \leq G_{30}(t) \leq \right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b_{30}')^{(5)})} \left[e^{(R_1)^{(5)} t} - e^{-(b_{30}')^{(5)} t} \right] + T_{30}^0 e^{-(b_{30}')^{(5)} t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})} \left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)} t} \right] + T_{30}^0 e^{-(R_2)^{(5)} t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)} (m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)} (\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33},t) + (a''_{33})^{(6)}(T_{33},t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}),t\big) - (b''_{33})^{(6)}\big((G_{35}),t\big) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},$ ***if*** $(\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}$, ***if*** $(\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},$ ***if*** $(\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},$ ***if*** $(u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}$, ***if*** $(u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)},$ ***if*** $(\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})} \left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t} \right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})} \left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t} \right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \le G_{36}(t) \le G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \le G_{37}(t) \le \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \le G_{38}(t) \le$ $\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}] + G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \le T_{36}(t) \le T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \le T_{36}(t) \le \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \le T_{38}(t) \le$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
<u>**Definition of**</u> $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$	370

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$

$(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)}$

$(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$

Behavior of the solutions of equation 371

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$:

$(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying

$-(\sigma_2)^{(8)} \le -(a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} - (a_{40}^{''})^{(8)}(T_{41}, t) + (a_{41}^{''})^{(8)}(T_{41}, t) \le -(\sigma_1)^{(8)}$

$-(\tau_2)^{(8)} \le -(b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (b_{40}^{''})^{(8)}\big((G_{43}), t\big) - (b_{41}^{''})^{(8)}\big((G_{43}), t\big) \le -(\tau_1)^{(8)}$

Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: 372

By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$
and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and

Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$:

By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the

roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$

and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$

Definition of $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:-

If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by

$(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)} < (\nu_1)^{(8)}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)},$ ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)},$
and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},$ ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)}T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)}T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>Definition of</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
<u>Behavior of the solutions of equation 37 to 92</u> **<u>Theorem 2:</u>** If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \leq -(a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} - (a_{44}^{''})^{(9)}(T_{45}, t) + (a_{45}^{''})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \leq -(b_{44}^{'})^{(9)} + (b_{45}^{'})^{(9)} - (b_{44}^{''})^{(9)}\big((G_{47}), t\big) - (b_{45}^{''})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

($\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$ $\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}\left[e^{(S_1)^{(9)}t}-e^{-(a_{46}')^{(9)}t}\right]+G_{46}^0 e^{-(a_{46}')^{(9)}t}$)	
$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b_{46}')^{(9)}t}\right]+T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$ $\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0 e^{-(R_2)^{(9)}t}$	
Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$ $(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$	

Proof : From global equations we obtain 383

$$\frac{dv^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)v^{(1)} - (a_{14})^{(1)}v^{(1)}$$

Definition of $v^{(1)}$:- $\boxed{v^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_2)^{(1)}v^{(1)} - (a_{13})^{(1)}\right) \le \frac{dv^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_1)^{(1)}v^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \ge \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \le \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \le \nu^{(1)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \le (\bar{\nu}_1)^{(1)} \le \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \le \nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get 391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
Proof : From global equations we obtain	398

$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:-	403

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{24}^{''})^{(4)} = (a_{25}^{''})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b_{24}^{''})^{(4)} = (b_{25}^{''})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}^{'})^{(5)} - (a_{29}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right) - (a_{29}^{''})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ **Definition of** $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

Proof : From global equations we obtain 416

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case** .

Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:-	424

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then
$(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}^{''})^{(9)} = (a_{45}^{''})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}^{''})^{(9)} = (b_{45}^{''})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i^{''})^{(1)} and\ (b_i^{''})^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}^{'})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}^{'})^{(1)}(r_{14})^{(1)} - (b_{14}^{'})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

$with\ \ (p_{13})^{(1)},(r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)}-(a_{16})^{(2)}(a_{17})^{(2)}<0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)}-(a_{16})^{(2)}(a_{17})^{(2)}+(a_{16})^{(2)}(p_{16})^{(2)}+(a_{17}^{'})^{(2)}(p_{17})^{(2)}+(p_{16})^{(2)}(p_{17})^{(2)}>0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}>0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-(b_{16}^{'})^{(2)}(r_{17})^{(2)}-(b_{17}^{'})^{(2)}(r_{17})^{(2)}+(r_{16})^{(2)}(r_{17})^{(2)}<0$ $with\ \ (p_{16})^{(2)},(r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}<0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}+(a_{20})^{(3)}(p_{20})^{(3)}+(a_{21}^{'})^{(3)}(p_{21})^{(3)}+(p_{20})^{(3)}(p_{21})^{(3)}>0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}>0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-(b_{20}^{'})^{(3)}(r_{21})^{(3)}-(b_{21}^{'})^{(3)}(r_{21})^{(3)}+(r_{20})^{(3)}(r_{21})^{(3)}<0$ $with\ \ (p_{20})^{(3)},(r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}<0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}+(a_{24})^{(4)}(p_{24})^{(4)}+(a_{25}^{'})^{(4)}(p_{25})^{(4)}+(p_{24})^{(4)}(p_{25})^{(4)}>0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}>0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-(b_{24}^{'})^{(4)}(r_{25})^{(4)}-(b_{25}^{'})^{(4)}(r_{25})^{(4)}+(r_{24})^{(4)}(r_{25})^{(4)}<0$ $with\ \ (p_{24})^{(4)},(r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}<0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}+(a_{28})^{(5)}(p_{28})^{(5)}+(a_{29}^{'})^{(5)}(p_{29})^{(5)}+(p_{28})^{(5)}(p_{29})^{(5)}>0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}>0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-(b_{28}^{'})^{(5)}(r_{29})^{(5)}-(b_{29}^{'})^{(5)}(r_{29})^{(5)}+(r_{28})^{(5)}(r_{29})^{(5)}<0$ $with\ \ (p_{28})^{(5)},(r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}')^{(1)} - (b_{14}'')^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}')^{(2)} - (b_{16}'')^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}')^{(2)} - (b_{17}'')^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}')^{(2)} - (b_{18}'')^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25})\right]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27}))\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}((G_{27}))\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27}))\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (e) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) +$	486

$(a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right] + (b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right] + (b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23})=(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23})+(b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27})=(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27})+(b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right]+(b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31})=(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31})+(b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right]+(b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35})=(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35})+(b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right]+(b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*})=0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39})=(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39})+(b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right]+(b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*})=0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43})=(b'_{40})^{(8)}(b'_{41})^{(8)}-(b_{40})^{(8)}(b_{41})^{(8)}-$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43})+(b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right]+(b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43})=0$ Where in $(G_{43})(G_{40},G_{41},G_{42}),G_{40},G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*)=0$	
By the same argument, the equations 92,93 admit solutions G_{44},G_{45} if $\varphi(G_{47})=(b'_{44})^{(9)}(b'_{45})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}-$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47})+(b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right]+(b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47})=0$ Where in $(G_{47})(G_{44},G_{45},G_{46}),G_{44},G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*)=0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*)=0$, T_{14}^* given by $f(T_{14}^*)=0$ and $G_{13}^*=\frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^*=\frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^*=\frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^*=\frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*)=0$, T_{17}^* given by $f(T_{17}^*)=0$ and	512
$G_{16}^*=\frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^*=\frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^*=\frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^*=\frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*)=0$, T_{21}^* given by $f(T_{21}^*)=0$ and $G_{20}^*=\frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^*=\frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^*=\frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^*=\frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^* = \frac{(a_{24})^{(4)}G_{25}^*}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)}G_{25}^*}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)}T_{25}^*}{[(b_{24}')^{(4)}-(b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)}T_{25}^*}{[(b_{26}')^{(4)}-(b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*)=0$, T_{29}^* given by $f(T_{29}^*)=0$ and $G_{28}^* = \frac{(a_{28})^{(5)}G_{29}^*}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)}G_{29}^*}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)}T_{29}^*}{[(b_{28}')^{(5)}-(b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)}T_{29}^*}{[(b_{30}')^{(5)}-(b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*)=0$, T_{33}^* given by $f(T_{33}^*)=0$ and $G_{32}^* = \frac{(a_{32})^{(6)}G_{33}^*}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)}G_{33}^*}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)}T_{33}^*}{[(b_{32}')^{(6)}-(b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)}T_{33}^*}{[(b_{34}')^{(6)}-(b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*)=0$, T_{37}^* given by $f(T_{37}^*)=0$ and $G_{36}^* = \frac{(a_{36})^{(7)}G_{37}^*}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)}G_{37}^*}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)}T_{37}^*}{[(b_{36}')^{(7)}-(b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)}T_{37}^*}{[(b_{38}')^{(7)}-(b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*)=0$, T_{41}^* given by $f(T_{41}^*)=0$ and $G_{40}^* = \frac{(a_{40})^{(8)}G_{41}^*}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)}G_{41}^*}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}(\,(G_{19})^*\,) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}(\,(G_{23})^*\,) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt}=-\left((b_{21}^{'})^{(3)}-(r_{21})^{(3)}\right)\mathbb{T}_{21}+(b_{21})^{(3)}\mathbb{T}_{20}+\sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt}=-\left((b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\mathbb{T}_{22}+(b_{22})^{(3)}\mathbb{T}_{21}+\sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i,\mathbb{T}_i$:- $G_i=G_i^*+\mathbb{G}_i \quad ,T_i=T_i^*+\mathbb{T}_i$ $\frac{\partial(a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*)=(q_{25})^{(4)} \quad , \frac{\partial(b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*})=s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt}=-\left((a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)\mathbb{G}_{24}+(a_{24})^{(4)}\mathbb{G}_{25}-(q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt}=-\left((a_{25}^{'})^{(4)}+(p_{25})^{(4)}\right)\mathbb{G}_{25}+(a_{25})^{(4)}\mathbb{G}_{24}-(q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt}=-\left((a_{26}^{'})^{(4)}+(p_{26})^{(4)}\right)\mathbb{G}_{26}+(a_{26})^{(4)}\mathbb{G}_{25}-(q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt}=-\left((b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)\mathbb{T}_{24}+(b_{24})^{(4)}\mathbb{T}_{25}+\sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt}=-\left((b_{25}^{'})^{(4)}-(r_{25})^{(4)}\right)\mathbb{T}_{25}+(b_{25})^{(4)}\mathbb{T}_{24}+\sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt}=-\left((b_{26}^{'})^{(4)}-(r_{26})^{(4)}\right)\mathbb{T}_{26}+(b_{26})^{(4)}\mathbb{T}_{25}+\sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i,\mathbb{T}_i$:- $G_i=G_i^*+\mathbb{G}_i \quad ,T_i=T_i^*+\mathbb{T}_i$ $\frac{\partial(a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*)=(q_{29})^{(5)} \quad , \frac{\partial(b_i^{''})^{(5)}}{\partial G_j}((G_{31})^{*})=s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G^*_{28}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G^*_{29}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G^*_{30}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T^*_{28}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T^*_{29}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T^*_{30}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 6:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(6)}$ *and* $(b''_i)^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	563
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{33})^{(6)}}{\partial T_{33}}(T^*_{33}) = (q_{33})^{(6)} \quad , \frac{\partial (b''_i)^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G^*_{32}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G^*_{33}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G^*_{34}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T^*_{32}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T^*_{33}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T^*_{34}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 7:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ *and* $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	571

<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **<u>Theorem 8:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\,\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i^{''})^{(8)}}{\partial G_j}(\,(G_{43})^{*}\,) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt}=-\left((b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)\mathbb{T}_{40}+(b_{40})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt}=-\left((b_{41}^{'})^{(8)}-(r_{41})^{(8)}\right)\mathbb{T}_{41}+(b_{41})^{(8)}\mathbb{T}_{40}+\sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt}=-\left((b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\mathbb{T}_{42}+(b_{42})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **<u>Proof:</u>** **Denote**	586 A
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \qquad ,T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*})=(q_{45})^{(9)} \quad , \frac{\partial(b_i^{''})^{(9)}}{\partial G_j}\left(\left(G_{47}\right)^{*}\right)=s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt}=-\left((a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\mathbb{G}_{44}+(a_{44})^{(9)}\mathbb{G}_{45}-(q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt}=-\left((a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)\mathbb{G}_{45}+(a_{45})^{(9)}\mathbb{G}_{44}-(q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt}=-\left((a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)\mathbb{G}_{46}+(a_{46})^{(9)}\mathbb{G}_{45}-(q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt}=-\left((b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)\mathbb{T}_{44}+(b_{44})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt}=-\left((b_{45}^{'})^{(9)}-(r_{45})^{(9)}\right)\mathbb{T}_{45}+(b_{45})^{(9)}\mathbb{T}_{44}+\sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt}=-\left((b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\mathbb{T}_{46}+(b_{46})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)}+(b_{15}^{'})^{(1)}-(r_{15})^{(1)}\right)\{\left((\lambda)^{(1)}+(a_{15}^{'})^{(1)}+(p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)})\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(2)} + (b_{18}^{'})^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a_{18}^{'})^{(2)} + (p_{18})^{(2)})$$

$$\left[\left(\left((\lambda)^{(2)} + (a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*} + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)} + (a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*} + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+((\lambda)^{(2)} + (a_{16}^{'})^{(2)} + (p_{16})^{(2)})\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(3)} + (b_{22}^{'})^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a_{22}^{'})^{(3)} + (p_{22})^{(3)})$$

$$\left[\left(\left((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)} + (a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*} + (a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$\left(\left((\lambda)^{(3)}\right)^2+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$ +	
$\left((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2+\left((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$\left((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$\left(\left((\lambda)^{(5)}\right)^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$ $\left(\left((\lambda)^{(5)}\right)^2 + \left((b'_{28})^{(5)} + (b'_{29})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$ $+\left(\left((\lambda)^{(5)}\right)^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right) (q_{30})^{(5)} G_{30}$ $+((\lambda)^{(5)} + (a'_{28})^{(5)} + (p_{28})^{(5)}) \left((a_{30})^{(5)}(q_{29})^{(5)} G^*_{29} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)} G^*_{28}\right)$ $\left(((\lambda)^{(5)} + (b'_{28})^{(5)} - (r_{28})^{(5)}) s_{(29),(30)} T^*_{29} + (b_{29})^{(5)} s_{(28),(30)} T^*_{28}\right)\} = 0$ $+$	
$((\lambda)^{(6)} + (b'_{34})^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a'_{34})^{(6)} + (p_{34})^{(6)})$ $\left[\left(((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)})(q_{33})^{(6)} G^*_{33} + (a_{33})^{(6)}(q_{32})^{(6)} G^*_{32}\right)\right]$ $\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}) s_{(33),(33)} T^*_{33} + (b_{33})^{(6)} s_{(32),(33)} T^*_{33}\right)$ $+\left(((\lambda)^{(6)} + (a'_{33})^{(6)} + (p_{33})^{(6)})(q_{32})^{(6)} G^*_{32} + (a_{32})^{(6)}(q_{33})^{(6)} G^*_{33}\right)$ $\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}) s_{(33),(32)} T^*_{33} + (b_{33})^{(6)} s_{(32),(32)} T^*_{32}\right)$ $\left(\left((\lambda)^{(6)}\right)^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$ $\left(\left((\lambda)^{(6)}\right)^2 + \left((b'_{32})^{(6)} + (b'_{33})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$ $+\left(\left((\lambda)^{(6)}\right)^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right) (q_{34})^{(6)} G_{34}$ $+((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)}) \left((a_{34})^{(6)}(q_{33})^{(6)} G^*_{33} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)} G^*_{32}\right)$ $\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}) s_{(33),(34)} T^*_{33} + (b_{33})^{(6)} s_{(32),(34)} T^*_{32}\right)\} = 0$ $+$ $((\lambda)^{(7)} + (b'_{38})^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a'_{38})^{(7)} + (p_{38})^{(7)})$ $\left[\left(((\lambda)^{(7)} + (a'_{36})^{(7)} + (p_{36})^{(7)})(q_{37})^{(7)} G^*_{37} + (a_{37})^{(7)}(q_{36})^{(7)} G^*_{36}\right)\right]$ $\left(((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)}) s_{(37),(37)} T^*_{37} + (b_{37})^{(7)} s_{(36),(37)} T^*_{37}\right)$ $+\left(((\lambda)^{(7)} + (a'_{37})^{(7)} + (p_{37})^{(7)})(q_{36})^{(7)} G^*_{36} + (a_{36})^{(7)}(q_{37})^{(7)} G^*_{37}\right)$ $\left(((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)}) s_{(37),(36)} T^*_{37} + (b_{37})^{(7)} s_{(36),(36)} T^*_{36}\right)$	

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)(q_{38})^{(7)} G_{38}$$

$$+\left((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\} = 0$$

$+$

$$\left((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\{\left((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)} G_{42}$$

$$+\left((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$$

$+$

$$\left((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\{\left((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION SIX

Zero Sound From Holography

INTRODUCTION—VARIABLES USED

Zero Sound from Holography A. Karch, D. T. Son, A. O. Starinets

(1) Quantum liquids are characterized by (eb) the distinctive properties such as the low temperature behavior of heat capacity and the spectrum of low-energy quasiparticle excitations.

(2) In particular, at low temperature, Fermi liquids exhibit (eb) the zero sound, predicted by L. D. Landau in 1957 and subsequently observed in (eb) liquid He-3. In this paper, authors tackle the question whether such a characteristic behavior is (=) present in (eb) theories with (e&eb) holographically dual description.

(3) They consider a class of gauge theories with (e&eb) fundamental matter fields whose holographic dual in (eb) the appropriate limit is given in terms of (e&eb)the Dirac-Born-Infeld action in (eb) AdS_{p+1} space.

(4) An example of such a system is (=) the N=4 SU (N_c) supersymmetric Yang-Mills theory with (e&eb) N_f massless N=2 hypermultiplets at (eb) strong coupling, finite baryon number density, and low temperature.

(5) Authors find that these systems exhibit (eb) a zero sound mode despite having (e) a non-Fermi liquid type behavior of the specific heat.

(6) These properties suggest (eb) that holography identifies (eb) a new type of quantum liquids. Subjects: High Energy Physics - Theory (hep-th); Other Condensed Matter (cond-mat.other) Journal reference: Phys.Rev. Lett. 102 (2009) 051602 DOI: 10.1103/PhysRevLett.102.051602

Report number: INT-PUB 08-24 Cite as: arXiv:0806.3796 [hep-th] (or arXiv:0806.3796v1 [hep-th] for this version)

NOTATION

Module One

Quantum liquids are characterized by (eb) the distinctive properties such as the low temperature behavior of heat capacity and the spectrum of low-energy quasiparticle excitations

G_{13} : Category one of **Quantum liquids;** distinctive properties such as the low temperature behavior of heat capacity and the spectrum of low-energy quasiparticle excitations

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of distinctive properties such as the low temperature behavior of heat capacity and the spectrum of low-energy quasiparticle excitations **;Quantum liquids**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

In particular, at low temperature, Fermi liquids exhibit (eb) the zero sound, predicted by L. D. Landau in 1957 and subsequently observed in (eb) liquid He-3. In this paper, authors tackle the question whether such a characteristic behavior is (=) present in (eb) theories with (e&eb) holographically dual description

G_{16} : Category one of Fermi liquids

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of zero sound, predicted by L. D. Landau in 1957 and subsequently observed in (eb) liquid He-3. In this paper, authors tackle the question whether such a characteristic behavior is (=) present in (eb) theories with (e&eb) holographically dual description

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

In particular, at low temperature, Fermi liquids exhibit the zero sound, predicted by L. D. Landau in 1957 and subsequently observed in (eb) liquid He-3.

In this paper, authors tackle the question whether such a characteristic behavior is (=) present in (eb) theories with (e&eb) holographically dual description

G_{20} : Category one of **Fermi liquids exhibit the zero sound, predicted by L. D. Landau in 1957 and subsequently observed;** liquid He-3

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of liquid He-3; **Fermi liquids exhibit the zero sound, predicted by L. D. Landau in 1957 and subsequently observed**

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

In this paper, authors tackle the question whether such a characteristic behavior is (=) present in (eb) theories with (e&eb) holographically dual description

G_{24} : Category one of such a characteristic behavior

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of present in (eb) theories with (e&eb) holographically dual description

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

In this paper, authors tackle the question whether **such a characteristic behavior is present in theories** with (e&eb) holographically dual description

G_{28} : Category one of **such a characteristic behavior is present in theories;** holographically dual description

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of holographically dual description **;such a characteristic behavior is present in theories**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

They consider a class of gauge theories with (e&eb) fundamental matter fields whose holographic dual in (eb) the appropriate limit is given in terms of (e&eb)the Dirac-Born-Infeld action in (eb) AdS_{p+1} space

G_{32} : Category one of **class of gauge theories;** fundamental matter fields whose holographic dual in (eb) the appropriate limit is given in terms of (e&eb)the Dirac-Born-Infeld action in (eb) AdS_{p+1} space

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of fundamental matter fields whose holographic dual in (eb) the appropriate limit is given in terms of (e&eb)the Dirac-Born-Infeld action in (eb) AdS_{p+1} space **;class of gauge theories**

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

They consider a class of gauge theories with fundamental matter fields whose holographic dual in (eb) the appropriate limit is given in terms of (e&eb)the Dirac-Born-Infeld action in (eb) AdS_{p+1} space

G_{36} : Category one of **class of gauge theories with fundamental matter fields whose holographic dual;** appropriate limit is given in terms of (e&eb)the Dirac-Born-Infeld action in (eb) AdS_{p+1} space

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of appropriate limit is given in terms of (e&eb)the Dirac-Born-Infeld action in (eb) AdS_{p+1} space **;class of gauge theories with fundamental matter fields whose holographic dual**

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

They consider a class of gauge theories with fundamental matter fields whose holographic dual in the appropriate limit is given in terms of (e&eb)the Dirac-Born-Infeld action in (eb) AdS_{p+1} space

G_{40} : Category one of **class of gauge theories with fundamental matter fields whose holographic dual in the appropriate limit;** Dirac-Born-Infeld action in (eb) AdS_{p+1} space

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of Dirac-Born-Infeld action in (eb) AdS_{p+1} space **;class of gauge theories with fundamental matter fields whose holographic dual in the appropriate limit**

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

They consider a class of gauge theories with fundamental matter fields whose holographic dual in the appropriate limit is given in terms of the Dirac-Born-Infeld action in (eb) AdS_{p+1} space

G_{44} : Category one of **class of gauge theories with fundamental matter fields whose holographic dual in the appropriate limit is given in terms of the Dirac-Born-Infeld action;** AdS_{p+1} space

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of AdS_{p+1} space **;class of gauge theories with fundamental matter fields whose holographic dual in the appropriate limit is given in terms of the Dirac-Born-Infeld action**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)} (T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)} (G, t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)} (G, t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)} (G, t) \right] T_{15}$	6
$+(a''_{13})^{(1)} (T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)} (G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	

$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}, t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}, t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}, t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}((G_{19}), t) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}((G_{19}), t) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}((G_{19}), t) \right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b''_{16})^{(2)}((G_{19}), t) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}, t) \right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}, t) \right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}, t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}, t) \right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}, t) \right] T_{22}$	18
$+(a''_{20})^{(3)}(T_{21}, t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23}, t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25}, t) \right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}, t) \right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}, t) \right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}((G_{27}), t) \right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}((G_{27}), t) \right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}((G_{27}), t) \right] T_{26}$	24
$+(a''_{24})^{(4)}(T_{25}, t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)}((G_{27}), t) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29}, t) \right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}, t) \right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}, t) \right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}((G_{31}), t) \right] T_{28}$	28

$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)} \big((G_{31}), t \big) \right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)} \big((G_{31}), t \big) \right] T_{30}$	30
$+(a''_{28})^{(5)} (T_{29}, t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)} \big((G_{31}), t \big) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)} (T_{33}, t) \right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)} (T_{33}, t) \right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)} (T_{33}, t) \right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)} \big((G_{35}), t \big) \right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)} \big((G_{35}), t \big) \right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)} \big((G_{35}), t \big) \right] T_{34}$	36
$+(a''_{32})^{(6)} (T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)} (T_{37}, t) \right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}, t) \right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}, t) \right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)} \big((G_{39}), t \big) \right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)} \big((G_{39}), t \big) \right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)} \big((G_{39}), t \big) \right] T_{38}$	*42*
$+(a''_{36})^{(7)} (T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)} (T_{41}, t) \right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}, t) \right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}, t) \right] G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)} \big((G_{43}), t \big) \right] T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)} \big((G_{43}), t \big) \right] T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)} \big((G_{43}), t \big) \right] T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)} (T_{45}, t) \right] G_{44}$	49

$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*55*
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	*56*
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	*57*
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58

$$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[\begin{matrix}(b_{14}^{'})^{(1)}\boxed{-(b_{14}^{''})^{(1)}(G,t)}\;\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}\;\boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}\;\boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)}\;\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{37}^{''})^{(7,7,)}(G_{39},t)}\;\boxed{-(b_{41}^{''})^{(8,8)}(G_{43},t)}\;\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{14}$$ 59

$$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[\begin{matrix}(b_{15}^{'})^{(1)}\boxed{-(b_{15}^{''})^{(1)}(G,t)}\;\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}\;\boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}\;\boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)}\;\boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}\;\boxed{-(b_{42}^{''})^{(8,8)}(G_{43},t)}\;\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{15}$$ 60

Where $\boxed{-(b_{13}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}^{''})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{40}^{''})^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{41}^{''})^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{42}^{''})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[\begin{matrix}(a_{16}^{'})^{(2)}\boxed{+(a_{16}^{''})^{(2)}(T_{17},t)}\;\boxed{+(a_{13}^{''})^{(1,1,)}(T_{14},t)}\;\boxed{+(a_{20}^{''})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4)}(T_{25},t)}\;\boxed{+(a_{28}^{''})^{(5,5,5,5,5)}(T_{29},t)}\;\boxed{+(a_{32}^{''})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{36}^{''})^{(7,7,7)}(T_{37},t)}\;\boxed{+(a_{40}^{''})^{(8,8,8)}(T_{41},t)}\;\boxed{+(a_{44}^{''})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{16}$$ 61

$$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[\begin{matrix}(a_{17}^{'})^{(2)}\boxed{+(a_{17}^{''})^{(2)}(T_{17},t)}\;\boxed{+(a_{14}^{''})^{(1,1,)}(T_{14},t)}\;\boxed{+(a_{21}^{''})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4)}(T_{25},t)}\;\boxed{+(a_{29}^{''})^{(5,5,5,5,5)}(T_{29},t)}\;\boxed{+(a_{33}^{''})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{37}^{''})^{(7,7,7)}(T_{37},t)}\;\boxed{+(a_{41}^{''})^{(8,8,8)}(T_{41},t)}\;\boxed{+(a_{45}^{''})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{17}$$ 62

$$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[\begin{matrix}(a_{18}^{'})^{(2)}\boxed{+(a_{18}^{''})^{(2)}(T_{17},t)}\;\boxed{+(a_{15}^{''})^{(1,1,)}(T_{14},t)}\;\boxed{+(a_{22}^{''})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4)}(T_{25},t)}\;\boxed{+(a_{30}^{''})^{(5,5,5,5,5)}(T_{29},t)}\;\boxed{+(a_{34}^{''})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{38}^{''})^{(7,7,7)}(T_{37},t)}\;\boxed{+(a_{42}^{''})^{(8,8,8)}(T_{41},t)}\;\boxed{+(a_{46}^{''})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{18}$$ 63

Where $\boxed{+(a_{16}^{''})^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3	

$-(b''_{36})^{(7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3 $-(b''_{40})^{(8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3 $-(b''_{44})^{(9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix}(a'_{20})^{(3)} +(a''_{20})^{(3)}(T_{21},t) +(a''_{16})^{(2,2,2)}(T_{17},t) +(a''_{13})^{(1,1,1,)}(T_{14},t) \\ +(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t) +(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t) +(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{36})^{(7,7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8,8)}(T_{41},t) +(a''_{44})^{(9,9,9)}(T_{45},t)\end{matrix}\right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix}(a'_{21})^{(3)} +(a''_{21})^{(3)}(T_{21},t) +(a''_{17})^{(2,2,2)}(T_{17},t) +(a''_{14})^{(1,1,1,)}(T_{14},t) \\ +(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t) +(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t) +(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{37})^{(7,7,7,7)}(T_{37},t) +(a''_{41})^{(8,8,8,8)}(T_{41},t) +(a''_{45})^{(9,9,9)}(T_{45},t)\end{matrix}\right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix}(a'_{22})^{(3)} +(a''_{22})^{(3)}(T_{21},t) +(a''_{18})^{(2,2,2)}(T_{17},t) +(a''_{15})^{(1,1,1,)}(T_{14},t) \\ +(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t) +(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t) +(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{38})^{(7,7,7,7)}(T_{37},t) +(a''_{42})^{(8,8,8,8)}(T_{41},t) +(a''_{46})^{(9,9,9)}(T_{45},t)\end{matrix}\right] G_{22}$	69
$+(a''_{20})^{(3)}(T_{21},t)$, $+(a''_{21})^{(3)}(T_{21},t)$, $+(a''_{22})^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3 $+(a''_{40})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3 $+(a''_{44})^{(9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix}(b'_{20})^{(3)} -(b''_{20})^{(3)}(G_{23},t) -(b''_{16})^{(2,2,2)}(G_{19},t) -(b''_{13})^{(1,1,1,)}(G,t) \\ -(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8,8)}(G_{43},t) -(b''_{44})^{(9,9,9)}(G_{47},t)\end{matrix}\right] T_{20}$	70

$$\frac{dT_{21}}{dt}=(b_{21})^{(3)}T_{20}-\begin{bmatrix}(b'_{21})^{(3)}-(b''_{21})^{(3)}(G_{23},t)-(b''_{17})^{(2,2,2)}(G_{19},t)-(b''_{14})^{(1,1,1,)}(G,t)\\-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)\\-(b''_{37})^{(7,7,7,7)}(G_{39},t)-(b''_{41})^{(8,8,8,8)}(G_{43},t)-(b''_{45})^{(9,9,9)}(G_{47},t)\end{bmatrix}T_{21} \quad 71$$

$$\frac{dT_{22}}{dt}=(b_{22})^{(3)}T_{21}-\begin{bmatrix}(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23},t)-(b''_{18})^{(2,2,2)}(G_{19},t)-(b''_{15})^{(1,1,1,)}(G,t)\\-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)\\-(b''_{38})^{(7,7,7,7)}(G_{39},t)-(b''_{42})^{(8,8,8,8)}(G_{43},t)-(b''_{46})^{(9,9,9)}(G_{47},t)\end{bmatrix}T_{22} \quad 72$$

$-(b''_{20})^{(3)}(G_{23},t)$, $-(b''_{21})^{(3)}(G_{23},t)$, $-(b''_{22})^{(3)}(G_{23},t)$ *are first detrition coefficients for category 1, 2 and 3*

$-(b''_{16})^{(2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2)}(G_{19},t)$ *are second detrition coefficients for category 1, 2 and 3*

$-(b''_{13})^{(1,1,1,)}(G,t)$, $-(b''_{14})^{(1,1,1,)}(G,t)$, $-(b''_{15})^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3*

$-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3*

$-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3*

$-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3*

$-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$ $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\begin{bmatrix}(a'_{24})^{(4)}+(a''_{24})^{(4)}(T_{25},t)+(a''_{28})^{(5,5,)}(T_{29},t)+(a''_{32})^{(6,6,)}(T_{33},t)\\+(a''_{13})^{(1,1,1,1)}(T_{14},t)+(a''_{16})^{(2,2,2,2)}(T_{17},t)+(a''_{20})^{(3,3,3,3)}(T_{21},t)\\+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)+(a''_{44})^{(9,9,9,9)}(T_{45},t)\end{bmatrix}G_{24} \quad 73$$

$$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\begin{bmatrix}(a'_{25})^{(4)}+(a''_{25})^{(4)}(T_{25},t)+(a''_{29})^{(5,5,)}(T_{29},t)+(a''_{33})^{(6,6)}(T_{33},t)\\+(a''_{14})^{(1,1,1,1)}(T_{14},t)+(a''_{17})^{(2,2,2,2)}(T_{17},t)+(a''_{21})^{(3,3,3,3)}(T_{21},t)\\+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)+(a''_{45})^{(9,9,9,9)}(T_{45},t)\end{bmatrix}G_{25} \quad 74$$

$$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\begin{bmatrix}(a'_{26})^{(4)}+(a''_{26})^{(4)}(T_{25},t)+(a''_{30})^{(5,5,)}(T_{29},t)+(a''_{34})^{(6,6,)}(T_{33},t)\\+(a''_{15})^{(1,1,1,1)}(T_{14},t)+(a''_{18})^{(2,2,2,2)}(T_{17},t)+(a''_{22})^{(3,3,3,3)}(T_{21},t)\\+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)+(a''_{46})^{(9,9,9,9)}(T_{45},t)\end{bmatrix}G_{26} \quad 75$$

$(a''_{24})^{(4)}(T_{25},t)$, $(a''_{25})^{(4)}(T_{25},t)$, $(a''_{26})^{(4)}(T_{25},t)$ *are first augmentation coefficients category* 1, 2 3

$+(a''_{28})^{(5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,)}(T_{29},t)$ *are second augmentation*

$coefficient\ \ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ \ augmentation$ $coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ $are\ fourth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ $are\ fifth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ $are\ sixth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ $are\ seventh\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ $are\ eighth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\begin{bmatrix}(b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{24}$	76
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\begin{bmatrix}(b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{25}$	77
$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\begin{bmatrix}(b'_{26})^{(4)}\boxed{-(b''_{26})^{(4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{26}$	78
$Where$ $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ $are\ first\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ $are\ second\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ $are\ fourth\ \ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ $are\ fifth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ $are\ sixth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$	

$are\ seventh\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b_{40}'')^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8,8)}(G_{43},t)}$ $are\ eighth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b_{46}'')^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a_{28}')^{(5)} \boxed{+(a_{28}'')^{(5)}(T_{29},t)} \boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$$	79
$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a_{29}')^{(5)} \boxed{+(a_{29}'')^{(5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$$	80
$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a_{30}')^{(5)} \boxed{+(a_{30}'')^{(5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$$	81
$Where$ $\boxed{+(a_{28}'')^{(5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5)}(T_{29},t)}$ $are\ first\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ And $\boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)}$ $are\ second\ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b_{28}')^{(5)} \boxed{-(b_{28}'')^{(5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{32}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$$	82

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \; \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \; \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \; \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \; \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{30} \quad 84$$

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \; \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{32} \quad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{34} \quad 87$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32}$	88
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)}\boxed{-(b''_{33})^{(6)}(G_{35},t)}\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33}$	89
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)}\boxed{-(b''_{34})^{(6)}(G_{35},t)}\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34}$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3	

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)}\boxed{+(a''_{36})^{(7)}(T_{37},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)}\boxed{+(a''_{37})^{(7)}(T_{37},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	92
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix} (a'_{38})^{(7)}\boxed{+(a''_{38})^{(7)}(T_{37},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$	93
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3	

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	

$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	95
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$,$\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$,$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{40}}{dt} =$	

$(b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13}$	96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$(b_{45})^{(9)}T_{44}-\begin{bmatrix}(b'_{45})^{(9)}\boxed{-(b''_{45})^{(9)}(G_{47},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{bmatrix}T_{14}$	
$\frac{dT_{46}}{dt}=$ $(b_{46})^{(9)}T_{45}-\begin{bmatrix}(b'_{46})^{(9)}\boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{bmatrix}T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)},(a'_i)^{(1)},(a''_i)^{(1)},(b_i)^{(1)},(b'_i)^{(1)},(b''_i)^{(1)}>0,\quad i,j=13,14,15$ The functions $(a''_i)^{(1)},(b''_i)^{(1)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(1)},\ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t)\le(p_i)^{(1)}\le(\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t)\le\ (r_i)^{(1)}\le(b'_i)^{(1)}\le(\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t)=(p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t)=\ (r_i)^{(1)}$	98

Definition of $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)},\ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}', t) - (a_i'')^{(1)}(T_{14}, t)\rvert \leq (\hat{k}_{13})^{(1)} \lvert T_{14} - T_{14}' \rvert e^{-(\hat{M}_{13})^{(1)} t}$ $\lvert(b_i'')^{(1)}(G', t) - (b_i'')^{(1)}(G, t)\rvert < (\hat{k}_{13})^{(1)} \lvert\lvert G - G' \rvert\rvert e^{-(\hat{M}_{13})^{(1)} t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}', t)$ and $(a_i'')^{(1)}(T_{14}, t)$. (T_{14}', t) and (T_{14}, t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\ , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)},\ (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[\, (a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[\, (b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i, j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(\mathrm{p_i})^{(2)},\ (\mathrm{r_i})^{(2)}$:	
$(a_i'')^{(2)}(T_{17}, t) \leq (p_i)^{(2)} \leq \left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i'')^{(2)}(G_{19}, t) \leq\ (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2 \to \infty} (a_i'')^{(2)}\,(T_{17}, t) = (p_i)^{(2)}$	104
$\lim_{G \to \infty} (b_i'')^{(2)} \left((G_{19}), t\right) =\ (r_i)^{(2)}$	105

Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}}$ are positive constants and $\boxed{i = 16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert (a_i'')^{(2)}(T_{17}', t) - (a_i'')^{(2)}(T_{17}, t) \rvert \leq (\hat{k}_{16})^{(2)} \lvert T_{17} - T_{17}' \rvert e^{-(\hat{M}_{16})^{(2)} t}$	107
$\lvert (b_i'')^{(2)}((G_{19})', t) - (b_i'')^{(2)}((G_{19}), t) \rvert < (\hat{k}_{16})^{(2)} \lvert\lvert (G_{19}) - (G_{19})' \rvert\rvert e^{-(\hat{M}_{16})^{(2)} t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}', t)$ and $(a_i'')^{(2)}(T_{17}, t)$. (T_{17}', t) and (T_{17}, t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}} [(a_i)^{(2)} + (a_i')^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}} [(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i, j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, (r_i)^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty} (a_i'')^{(3)} (T_{21}, t) = (p_i)^{(3)}$	113

$\lim_{G\to\infty}(b_i'')^{(3)}(G_{23},t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(3)}(T_{21}',t) - (a_i'')^{(3)}(T_{21},t)\rvert \le (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i'')^{(3)}(G_{23}',t) - (b_i'')^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and$(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \le (p_i)^{(4)} \le (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t) \le (r_i)^{(4)} \le (b_i')^{(4)} \le (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t) = (p_i)^{(4)}$	118

$\lim_{G\to\infty}(b_i^{''})^{(4)}\left((G_{27}),t\right) = (r_i)^{(4)}$ **<u>Definition of</u>** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}\left((G_{27}),t\right)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
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Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}\left((G_{31}),t\right) \leq (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	122

$lim_{T_2 \to \infty} (a_i^{''})^{(5)} (T_{29}, t) = (p_i)^{(5)}$ $\lim_{G \to \infty} (b_i^{''})^{(5)} (G_{31}, t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}$ are positive constants and $i = 28,29,30$	123
They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(5)}(T_{29}', t) - (a_i^{''})^{(5)}(T_{29}, t) \rvert \leq (\hat{k}_{28})^{(5)} \lvert T_{29} - T_{29}' \rvert e^{-(\hat{M}_{28})^{(5)} t}$ $\lvert (b_i^{''})^{(5)}((G_{31})', t) - (b_i^{''})^{(5)}((G_{31}), t) \rvert < (\hat{k}_{28})^{(5)} \lvert\lvert (G_{31}) - (G_{31})' \rvert\lvert e^{-(\hat{M}_{28})^{(5)} t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}', t)$ and$(a_i^{''})^{(5)}(T_{29}, t)$. (T_{29}', t) and (T_{29}, t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}} , \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}} [(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}} [(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i^{''})^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i^{''})^{(6)} > 0, \quad i, j = 32,33,34$ The functions $(a_i^{''})^{(6)}, (b_i^{''})^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i^{''})^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$	127

$(b_i^{''})^{(6)}((G_{35}),t) \leq \ (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(6)}(T_{33},t) = (p_i)^{(6)}$ $\lim_{G\to\infty}(b_i^{''})^{(6)}\left((G_{35}),t\right) = \ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(6)}(T_{33}^{'},t) - (a_i^{''})^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)}\lvert T_{33} - T_{33}^{'}\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i^{''})^{(6)}((G_{35})^{'},t) - (b_i^{''})^{(6)}\left((G_{35}),t\right)\rvert < (\hat{k}_{32})^{(6)}\lvert\lvert(G_{35}) - (G_{35})^{'}\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'},t)$ and $(a_i^{''})^{(6)}(T_{33},t)$. $(T_{33}^{'},t)$ and (T_{33},t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i^{'})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i^{'})^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)}\ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ \ (b_i)^{(6)} + (b_i^{'})^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)}\ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(EE) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (FF) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, \ (r_i)^{(7)}$:	131

$(a_i^{''})^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39},t) \leq (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	
(GG) $\lim_{T_2\to\infty} (a_i^{''})^{(7)}(T_{37},t) = (p_i)^{(7)}$ *(HH)* $\lim_{G\to\infty} (b_i^{''})^{(7)}((G_{39}),t) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$	132
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(7)}(T_{37}^{'},t) - (a_i^{''})^{(7)}(T_{37},t)\rvert \leq (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}^{'}\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i^{''})^{(7)}((G_{39})^{'},t) - (b_i^{''})^{(7)}((G_{39}),t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})^{'}\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'},t)$ and $(a_i^{''})^{(7)}(T_{37},t)$. $(T_{37}^{'},t)$ and (T_{37},t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (II) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
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Where we suppose	

$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
<u>Definition of</u> $(p_i)^{(8)}, \ (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}), t) \leq \ (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2 \to \infty} (a_i'')^{(8)} (T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G \to \infty} (b_i'')^{(8)} \left((G_{43}), t\right) = \ (r_i)^{(8)}$	141
<u>Definition of</u> $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t)\rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)} t}$	142
$\lvert(b_i'')^{(8)}((G_{43})', t) - (b_i'')^{(8)}\left((G_{43}), t\right)\rvert < (\hat{k}_{40})^{(8)} \lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)} t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}', t)$ and $(a_i'')^{(8)}(T_{41}, t)$. (T_{41}', t) and (T_{41}, t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}} \ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
<u>Definition of</u> $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}} [(a_i)^{(8)} + (a_i')^{(8)} + \ (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)} (\hat{k}_{40})^{(8)}] < 1$	145

$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i^{'})^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)} (\hat{k}_{40})^{(8)}] < 1$	146
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$(a_i)^{(9)}, (a_i^{'})^{(9)}, (a_i^{''})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (b_i^{''})^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45}, t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47}, t) \leq (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2 \to \infty} (a_i^{''})^{(9)} (T_{45}, t) = (p_i)^{(9)}$ $\lim_{G \to \infty} (b_i^{''})^{(9)} (G_{47}, t) = (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$: Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$	
They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(9)}(T_{45}^{'}, t) - (a_i^{''})^{(9)}(T_{45}, t) \rvert \leq (\hat{k}_{44})^{(9)} \lvert T_{45} - T_{45}^{'} \rvert e^{-(\hat{M}_{44})^{(9)} t}$ $\lvert (b_i^{''})^{(9)}((G_{47})^{'}, t) - (b_i^{''})^{(9)}((G_{47}), t) \rvert < (\hat{k}_{44})^{(9)} \lvert\lvert (G_{47}) - (G_{47})^{'} \rvert\rvert e^{-(\hat{M}_{44})^{(9)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'}, t)$ and $(a_i^{''})^{(9)}(T_{45}, t)$. $(T_{45}^{'}, t)$ and (T_{45}, t) are points belonging to the interval $[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities	

$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i')^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i')^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t)\leq(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0)=G_i^0>0}$ $T_i(t)\leq(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0)=T_i^0>0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t)\leq(\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0)=G_i^0>0$ $T_i(t)\leq(\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0)=T_i^0>0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t)\leq(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0)=G_i^0>0$ $T_i(t)\leq(\hat{Q}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0)=T_i^0>0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t)\leq(\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0)=G_i^0>0}$ $T_i(t)\leq(\hat{Q}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0)=T_i^0>0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t)\leq(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0)=G_i^0>0}$ $T_i(t)\leq(\hat{Q}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0)=T_i^0>0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	152

$G_i(t) \leq \left(\hat{P}_{32} \right)^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>**Definition of**</u> $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>**Definition of**</u> $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>**Definition of**</u> $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
<u>**Proof:**</u> Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)} \left(T_{14}(s_{(13)}), s_{(13)} \right) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)} \left(T_{14}(s_{(13)}), s_{(13)} \right) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)} \left(T_{14}(s_{(13)}), s_{(13)} \right) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	

$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a'_{20})^{(3)} + a''_{20})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0\leq(\hat{P}_{28})^{(5)}\ ,T_i^0\leq(\hat{Q}_{28})^{(5)},$	
$0\leq G_i(t)-G_i^0\leq(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$	
$0\leq T_i(t)-T_i^0\leq(\hat{Q}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$	
By $\bar{G}_{28}(t)=G_{28}^0+\int_0^t\left[(a_{28})^{(5)}G_{29}(s_{(28)})-\left((a_{28}^{'})^{(5)}+a_{28}^{''})^{(5)}(T_{29}(s_{(28)}),s_{(28)})\right)G_{28}(s_{(28)})\right]ds_{(28)}$	163
$\bar{G}_{29}(t)=G_{29}^0+\int_0^t\left[(a_{29})^{(5)}G_{28}(s_{(28)})-\left((a_{29}^{'})^{(5)}+(a_{29}^{''})^{(5)}(T_{29}(s_{(28)}),s_{(28)})\right)G_{29}(s_{(28)})\right]ds_{(28)}$	
$\bar{G}_{30}(t)=G_{30}^0+\int_0^t\left[(a_{30})^{(5)}G_{29}(s_{(28)})-\left((a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}(s_{(28)}),s_{(28)})\right)G_{30}(s_{(28)})\right]ds_{(28)}$	
$\bar{T}_{28}(t)=T_{28}^0+\int_0^t\left[(b_{28})^{(5)}T_{29}(s_{(28)})-\left((b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}(G_{31}(s_{(28)}),s_{(28)})\right)T_{28}(s_{(28)})\right]ds_{(28)}$	
$\bar{T}_{29}(t)=T_{29}^0+\int_0^t\left[(b_{29})^{(5)}T_{28}(s_{(28)})-\left((b_{29}^{'})^{(5)}-(b_{29}^{''})^{(5)}(G_{31}(s_{(28)}),s_{(28)})\right)T_{29}(s_{(28)})\right]ds_{(28)}$	
$\bar{T}_{30}(t)=T_{30}^0+\int_0^t\left[(b_{30})^{(5)}T_{29}(s_{(28)})-\left((b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}(G_{31}(s_{(28)}),s_{(28)})\right)T_{30}(s_{(28)})\right]ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i:\mathbb{R}_+\rightarrow\mathbb{R}_+$ which satisfy	
$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0\leq(\hat{P}_{32})^{(6)}\ ,T_i^0\leq(\hat{Q}_{32})^{(6)},$	
$0\leq G_i(t)-G_i^0\leq(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$	
$0\leq T_i(t)-T_i^0\leq(\hat{Q}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$	
By $\bar{G}_{32}(t)=G_{32}^0+\int_0^t\left[(a_{32})^{(6)}G_{33}(s_{(32)})-\left((a_{32}^{'})^{(6)}+a_{32}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{32}(s_{(32)})\right]ds_{(32)}$	164
$\bar{G}_{33}(t)=G_{33}^0+\int_0^t\left[(a_{33})^{(6)}G_{32}(s_{(32)})-\left((a_{33}^{'})^{(6)}+(a_{33}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{33}(s_{(32)})\right]ds_{(32)}$	
$\bar{G}_{34}(t)=G_{34}^0+\int_0^t\left[(a_{34})^{(6)}G_{33}(s_{(32)})-\left((a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{34}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{32}(t)=T_{32}^0+\int_0^t\left[(b_{32})^{(6)}T_{33}(s_{(32)})-\left((b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{32}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{33}(t)=T_{33}^0+\int_0^t\left[(b_{33})^{(6)}T_{32}(s_{(32)})-\left((b_{33}^{'})^{(6)}-(b_{33}^{''})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{33}(s_{(32)})\right]ds_{(32)}$	

$\overline{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$

Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{36})^{(7)}, T_i^0 \leq (\hat{Q}_{36})^{(7)}$,

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$

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$\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$

$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$

$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$

$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$

$\overline{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$

Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$

By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$, $T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a'_{44})^{(9)} + a''_{44})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
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$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
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$$\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{Q}_{28})^{(5)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{28})^{(5)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{28})^{(5)}\right]\leq(\hat{Q}_{28})^{(5)}$$ 235

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$$d\left(\left((G_{31})^{(1)},(T_{31})^{(1)}\right),\left((G_{31})^{(2)},(T_{31})^{(2)}\right)\right)=$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\hat{M}_{28})^{(5)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\hat{M}_{28})^{(5)}t}\}$$

Indeed if we denote

<u>Definition of</u> $\widetilde{(G_{31})},\widetilde{(T_{31})}$: $\left(\widetilde{(G_{31})},\widetilde{(T_{31})}\right)=\mathcal{A}^{(5)}\left((G_{31}),(T_{31})\right)$

It results

$$\left|\tilde{G}_{28}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{28})^{(5)}\left|G_{29}^{(1)}-G_{29}^{(2)}\right|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}}ds_{(28)}+$$

$$\int_0^t\{(a_{28}')^{(5)}\left|G_{28}^{(1)}-G_{28}^{(2)}\right|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{-(\hat{M}_{28})^{(5)}s_{(28)}}+$$

$$(a_{28}'')^{(5)}\left(T_{29}^{(1)},s_{(28)}\right)\left|G_{28}^{(1)}-G_{28}^{(2)}\right|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}}+$$

$$G_{28}^{(2)}|(a_{28}'')^{(5)}\left(T_{29}^{(1)},s_{(28)}\right)-(a_{28}'')^{(5)}\left(T_{29}^{(2)},s_{(28)}\right)|\ e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\}ds_{(28)}$$

Where $s_{(28)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on it follows

$$\left|(G_{31})^{(1)}-(G_{31})^{(2)}\right|e^{-(\hat{M}_{28})^{(5)}t}\leq$$ 237

$$\frac{1}{(\hat{M}_{28})^{(5)}}\left((a_{28})^{(5)}+(a_{28}')^{(5)}+(\hat{A}_{28})^{(5)}+(\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}\right)d\left(\left((G_{31})^{(1)},(T_{31})^{(1)};\ (G_{31})^{(2)},(T_{31})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

<u>**Remark 21:**</u> The fact that we supposed $(a_{28}'')^{(5)}$ and $(b_{28}'')^{(5)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$ *and* $(\hat{Q}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$ respectively of $\mathbb{R}_+$. 238

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(5)}$ and $(b_i'')^{(5)}, i=28,29,30$ depend only on T_{29} and respectively on (G_{31})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

<u>**Remark 22:**</u> There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$ 239

it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(5)}-(a_i^{''})^{(5)}(T_{29}(s_{(28)}),s_{(28)})\}ds_{(28)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(5)}t\right)} > 0$ for $t > 0$	
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$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[(\hat{P}_{32})^{(6)}+((\hat{P}_{32})^{(6)}+G_j^0)e^{-\left(\frac{(\hat{P}_{32})^{(6)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{32})^{(6)}$	245
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Remark 27: There does not exist any t where $G_i(t) = 0\ and\ T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(6)} - (a_i'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\} ds_{(32)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(6)} t)} > 0$ for t > 0	250
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Analogous inequalities hold also for G_{37} , $G_{38}, T_{36}, T_{37}, T_{38}$ It is now sufficient to take $\frac{(a_i)^{(7)}}{(\mathcal{M}_{36})^{(7)}}$, $\frac{(b_i)^{(7)}}{(\mathcal{M}_{36})^{(7)}} < 1$ and to choose $(\widehat{P}_{36})^{(7)}$ and $(\widehat{Q}_{36})^{(7)}$ large to have	255

$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[(\hat{P}_{36})^{(7)}+((\hat{P}_{36})^{(7)}+G_j^0)e^{-\left(\frac{(\hat{P}_{36})^{(7)}+G_j^0}{G_j^0}\right)}\right]\le(\hat{P}_{36})^{(7)}$	256
$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[((\hat{Q}_{36})^{(7)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{36})^{(7)}\right]\le(\hat{Q}_{36})^{(7)}$	257
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suffices to consider that $(a_i^{''})^{(7)}$ and $(b_i^{''})^{(7)}, i = 36,37,38$ depend only on T_{37} and respectively on $(G_{39})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 32: There does not exist any t where $G_i\,(t) = 0\ and\ T_i\,(t) = 0$ it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(7)} - (a_i^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\} ds_{(36)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(7)} t)} > 0$ for t > 0	261
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In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
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$d\left(((G_{43})^{(1)},(T_{43})^{(1)}),((G_{43})^{(2)},(T_{43})^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **<u>Definition of</u>** $\widetilde{(G_{43})}, \widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
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condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ *and* $(\hat{Q}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on $(G_{43})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 37 There does not exist any t where $G_i(t) = 0\ and\ T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t\{(a_i')^{(8)}-(a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for t > 0	275
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Remark 39: If G_{40} *is* bounded, from below, the same property holds for $G_{41}\ and\ G_{42}$. The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\left((G_{43})(t),t\right) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results	279

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right)$, $t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\left((G_{43})(t), t(t), t\right) = (b_{42}')^{(8)}$

It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + ((\widehat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[((\widehat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}), (T_{47})\right)$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}ds_{(44)} +$$
$$\int_0^t\{(a_{44}')^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a_{44}'')^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a_{44}'')^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a_{44}'')^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)|\ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	
Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ From 99 to 44 it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)}t)} > 0$ for $t > 0$	
Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$: **Remark 43:** if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if $G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating $G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$ In the same way , one can obtain $G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$ If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.	
Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.	
Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \le -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14}, t) + (a_{14}'')^{(1)}(T_{14}, t) \le -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \le -(b_{13}')^{(1)} + (b_{14}')^{(1)} - (b_{13}'')^{(1)}(G, t) - (b_{14}'')^{(1)}(G, t) \le -(\tau_1)^{(1)}$	280
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$\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	
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$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
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<u>Definition of</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
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$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)},(\nu_2)^{(4)},(u_1)^{(4)},(u_2)^{(4)},\nu^{(4)},u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
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and analogously $(\mu_2)^{(4)} = (u_0)^{(4)},(\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)},(\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)},(\mu_1)^{(4)} = (u_0)^{(4)},\boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)},(\bar{u}_1)^{(4)}$	331
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$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\big((G_{31}), t\big) - (b_{29}'')^{(5)}\big((G_{31}), t\big) \leq -(\tau_1)^{(5)}$	338
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Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}, \ \textit{\textbf{if}} \ (\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}, \textit{\textbf{if}} \ (\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,	340

and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}, \ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}, \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
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$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b'_{30})^{(5)}t}\right] + T_{30}^0 e^{-(b'_{30})^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a'_{28})^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b'_{28})^{(5)}$ $(R_2)^{(5)} = (b'_{30})^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$:

$(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying

$$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$$

$$-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}((G_{35}), t) - (b''_{33})^{(6)}((G_{35}), t) \leq -(\tau_1)^{(6)}$$

Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: 350

By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$

and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and

Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: 351

By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$

and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$

Definition of $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:-

If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by

$$(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \ \boldsymbol{if} \ (\nu_0)^{(6)} < (\nu_1)^{(6)}$$

$$(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)},$$

and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$

$$(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$$

and analogously 352

$$(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \ \boldsymbol{if} \ (u_0)^{(6)} < (u_1)^{(6)}$$

$$(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if} \ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$$

and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$

$(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$

Then the solution of global equations satisfies the inequalities 353

$$G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$$

where $(p_i)^{(6)}$ is defined by equation

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the	362

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq \frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}^{'})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)}$ $(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} - (a_{40}^{''})^{(8)}(T_{41}, t) + (a_{41}^{''})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43}), t) - (b_{41}^{''})^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}, \; \boldsymbol{if} \; (\nu_0)^{(8)} < (\nu_1)^{(8)}$	

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, $\boldsymbol{if}$ $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}$ $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}$ $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a'_{42})^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a'_{42})^{(8)}t}\right] + G_{42}^0 e^{-(a'_{42})^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$

$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,
and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,
and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^{0} e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^{0} e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^{0} e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^{0} e^{(S_1)^{(9)}t}$$

$$\Bigg(\frac{(a_{46})^{(9)} G_{44}^{0}}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^{0} e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} G_{44}^{0}}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}\left[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}\right] + G_{46}^{0} e^{-(a_{46}')^{(9)}t}\Bigg)$$

$$\boxed{T_{44}^{0} e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^{0} e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^{0} e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^{0} e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^{0}}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^{0} e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^{0}}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^{0} e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{dv^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)v^{(1)} - (a_{14})^{(1)}v^{(1)}$$

Definition of $v^{(1)}$:- $\boxed{v^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_2)^{(1)}v^{(1)} - (a_{13})^{(1)}\right) \leq \frac{dv^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_1)^{(1)}v^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}$, $\boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390
In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393

If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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In a completely analogous way, we obtain **<u>Definition of</u>** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}, \quad \boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
<u>Particular case :</u> If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)} G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)} T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21}, t)\right) - (a''_{21})^{(3)}(T_{21}, t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
<u>Definition of</u> $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$$

Definition of $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
Proof : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **Definition of** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	405
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}$, $\boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)}$, $\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)}$, $\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$**, and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \le \frac{d\nu^{(7)}}{dt} \le -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \ge \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \le \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \le \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \le \nu^{(7)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}, \quad \boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}, \quad \boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)}G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)}T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

$with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system

Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations 426

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$ 427

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$ 428

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$, 429

$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with$ $(p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with$ $(p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with$ $(p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with$ $(p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

$with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\,]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\,]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\,]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\,]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\,]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\,]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\,]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\,]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\big((G_{27})\big)\,]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\big((G_{27})\big)\,]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\big((G_{27})\big)\,]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\,]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (f) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	499
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right]+(b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right]+(b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi({G_{35}}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi({G_{39}}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi({G_{43}}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b'_{16})^{(2)} - (b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b'_{18})^{(2)} - (b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b'_{24})^{(4)} - (b''_{24})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b'_{26})^{(4)} - (b''_{26})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$	523 A

$$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]} \quad , \quad T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$$

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Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof:_Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)} \quad , \frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$$

Then taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$$ 525

$$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$$ 526

$$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$$ 527

$$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$$ 528

$$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$$ 529

$$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$$ 530

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Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$$ 532

$$\frac{\partial (a_{17}'')^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$$ 533

taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$$ 534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_{j}\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_{j}\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_{j}\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \ , \ \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}\left((G_{23})^{*}\right) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_{j}\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_{j}\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_{j}\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$

$\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}} (T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j} ((G_{27})^* \ ) = s_{ij}$

Then taking into account equations and neglecting the terms of power 2, we obtain

$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)} G_{24}^* \mathbb{T}_{25}$ 549

$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)} G_{25}^* \mathbb{T}_{25}$ 550

$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)} G_{26}^* \mathbb{T}_{25}$ 551

$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)} T_{24}^* \mathbb{G}_j\right)$ 552

$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)} T_{25}^* \mathbb{G}_j\right)$ 553

$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)} T_{26}^* \mathbb{G}_j\right)$ 554

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Theorem 5: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- 556

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$

$\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}} (T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j} ((G_{31})^*) = s_{ij}$

Then taking into account equations and neglecting the terms of power 2, we obtain

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)} G_{28}^* \mathbb{T}_{29}$ 557

$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)} G_{29}^* \mathbb{T}_{29}$ 558

$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)} G_{30}^* \mathbb{T}_{29}$ 559

$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)} T_{28}^* \mathbb{G}_j\right)$ 560

$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)} T_{29}^* \mathbb{G}_j\right)$ 561

$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)} T_{30}^* \mathbb{G}_j\right)$ 562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G_{38}^* \mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T_{36}^* \mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T_{37}^* \mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T_{38}^* \mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \;,\; \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left(\left(G_{43}\right)^*\right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G_{40}^* \mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G_{41}^* \mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)} G_{42}^* \mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)} T_{40}^* \mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)} T_{41}^* \mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)} T_{42}^* \mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(9)}$ *and* $(b_i'')^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i'')^{(9)}}{\partial G_j}((G_{47})^*) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^*\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^*\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^*\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^*\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^*\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^*\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}')^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^* + (b_{14})^{(1)}s_{(13),(13)}T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$ $+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$ +	

$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

+

$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$

$+\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$

+

$$((\lambda)^{(4)} + (b'_{26})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a'_{26})^{(4)} + (p_{26})^{(4)})$$

$$\left[\left(((\lambda)^{(4)} + (a'_{24})^{(4)} + (p_{24})^{(4)})(q_{25})^{(4)}G^*_{25} + (a_{25})^{(4)}(q_{24})^{(4)}G^*_{24}\right)\right]$$

$$\left(((\lambda)^{(4)} + (b'_{24})^{(4)} - (r_{24})^{(4)})s_{(25),(25)}T^*_{25} + (b_{25})^{(4)}s_{(24),(25)}T^*_{25}\right)$$

$$+\left(((\lambda)^{(4)} + (a'_{25})^{(4)} + (p_{25})^{(4)})(q_{24})^{(4)}G^*_{24} + (a_{24})^{(4)}(q_{25})^{(4)}G^*_{25}\right)$$

$$\left(((\lambda)^{(4)} + (b'_{24})^{(4)} - (r_{24})^{(4)})s_{(25),(24)}T^*_{25} + (b_{25})^{(4)}s_{(24),(24)}T^*_{24}\right)$$

$$\left(((\lambda)^{(4)})^2 + \left((a'_{24})^{(4)} + (a'_{25})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$\left(((\lambda)^{(4)})^2 + \left((b'_{24})^{(4)} + (b'_{25})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$+\left(((\lambda)^{(4)})^2 + \left((a'_{24})^{(4)} + (a'_{25})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$$

$$+((\lambda)^{(4)} + (a'_{24})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G^*_{25} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G^*_{24}\right)$$

$$\left(((\lambda)^{(4)} + (b'_{24})^{(4)} - (r_{24})^{(4)})s_{(25),(26)}T^*_{25} + (b_{25})^{(4)}s_{(24),(26)}T^*_{24}\right)\} = 0$$

+

$$((\lambda)^{(5)} + (b'_{30})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a'_{30})^{(5)} + (p_{30})^{(5)})$$

$$\left[\left(((\lambda)^{(5)} + (a'_{28})^{(5)} + (p_{28})^{(5)})(q_{29})^{(5)}G^*_{29} + (a_{29})^{(5)}(q_{28})^{(5)}G^*_{28}\right)\right]$$

$$\left(((\lambda)^{(5)} + (b'_{28})^{(5)} - (r_{28})^{(5)})s_{(29),(29)}T^*_{29} + (b_{29})^{(5)}s_{(28),(29)}T^*_{29}\right)$$

$$+\left(((\lambda)^{(5)} + (a'_{29})^{(5)} + (p_{29})^{(5)})(q_{28})^{(5)}G^*_{28} + (a_{28})^{(5)}(q_{29})^{(5)}G^*_{29}\right)$$

$$\left(((\lambda)^{(5)} + (b'_{28})^{(5)} - (r_{28})^{(5)})s_{(29),(28)}T^*_{29} + (b_{29})^{(5)}s_{(28),(28)}T^*_{28}\right)$$

$$\left(((\lambda)^{(5)})^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(((\lambda)^{(5)})^2 + \left((b'_{28})^{(5)} + (b'_{29})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(((\lambda)^{(5)})^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+((\lambda)^{(5)} + (a'_{28})^{(5)} + (p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G^*_{29} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G^*_{28}\right)$$

$$\left(((\lambda)^{(5)} + (b'_{28})^{(5)} - (r_{28})^{(5)})s_{(29),(30)}T^*_{29} + (b_{29})^{(5)}s_{(28),(30)}T^*_{28}\right)\} = 0$$

+

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$((\lambda)^{(8)} + (b'_{42})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a'_{42})^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(q_{40})^{(8)}G^*_{40}\right)\right]$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T^*_{41} + (b_{41})^{(8)}s_{(40),(41)}T^*_{41}\right)$$

$$+\left(((\lambda)^{(8)} + (a'_{41})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G^*_{40} + (a_{40})^{(8)}(q_{41})^{(8)}G^*_{41}\right)$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T^*_{41} + (b_{41})^{(8)}s_{(40),(40)}T^*_{40}\right)$$

$$\left(((\lambda)^{(8)})^2 + \left((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(((\lambda)^{(8)})^2 + \left((b'_{40})^{(8)} + (b'_{41})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(((\lambda)^{(8)})^2 + \left((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G^*_{40}\right)$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T^*_{41} + (b_{41})^{(8)}s_{(40),(42)}T^*_{40}\right)\} = 0$$

$+$

$$((\lambda)^{(9)} + (b'_{46})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a'_{46})^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(q_{44})^{(9)}G^*_{44}\right)\right]$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T^*_{45} + (b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$$

$$+\left(((\lambda)^{(9)} + (a'_{45})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G^*_{44} + (a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T^*_{45} + (b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$$

$$\left(((\lambda)^{(9)})^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$\left(((\lambda)^{(9)})^2 + \left((b'_{44})^{(9)} + (b'_{45})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$+\left(((\lambda)^{(9)})^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T^*_{45} + (b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\} = 0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.	

SECTION SEVEN

Zero Sound From Holography-2

INTRODUCTION—VARIABLES USED

Zero Sound from Holography A. Karch, D. T. Son, A. O. Starinets

(1) An example of such a system is (=) the N=4 SU (N_c) supersymmetric Yang-Mills theory with (e&eb) N_f massless N=2 hypermultiplets at (eb) strong coupling, finite baryon number density, and low temperature.

(2) Authors find that these systems exhibit (eb) a zero sound mode despite having (e) a non-Fermi liquid type behavior of the specific heat.

(3) These properties suggest (eb) that holography identifies (eb) a new type of quantum liquids. Subjects: High Energy Physics - Theory (hep-th); Other Condensed Matter (cond-mat.other) Journal reference: Phys.Rev. Lett. 102 (2009) 051602 DOI: 10.1103/PhysRevLett.102.051602 Report number: INT-PUB 08-24 Cite as: arXiv:0806.3796 [hep-th] (or arXiv:0806.3796v1 [hep-th] for this version)

NOTATION

Module One

An example of such a system is (=) the N=4 SU (N_c) supersymmetric Yang-Mills theory with (e&eb) N_f massless N=2 hypermultiplets at (eb) strong coupling, finite baryon number density, and low temperature

G_{13} : Category one of example of such a system

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of N=4 SU (N_c) supersymmetric Yang-Mills theory with (e&eb) N_f massless N=2 hypermultiplets at (eb) strong coupling, finite baryon number density, and low temperature

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

An example of such a system is the N=4 SU (N_c) supersymmetric Yang-Mills theory with (e&eb) N_f massless N=2 hypermultiplets at (eb) strong coupling, finite baryon number density, and low temperature

G_{16} : Category one of **example of such a system is the N=4 SU (N_c) supersymmetric Yang-Mills theory;** N_f massless N=2 hypermultiplets at (eb) strong coupling, finite baryon number density, and low temperature

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of N_f massless N=2 hypermultiplets at (eb) strong coupling, finite baryon number density, and low temperature **;example of such a system is the N=4 SU (N_c) supersymmetric Yang-Mills theory**

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

An example of such a system is the N=4 SU (N_c) supersymmetric Yang-Mills theory with N_f massless N=2 hypermultiplets at (eb) strong coupling, finite baryon number density, and low temperature

G_{20} : Category one of example of such a system is the N=4 SU (N_c) supersymmetric Yang-Mills theory with N_f massless N=2 hypermultiplets

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of strong coupling, finite baryon number density, and low temperature

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

Authors find that these systems exhibit (eb) a zero sound mode despite having (e) a non-Fermi liquid type behavior of the specific heat

G_{24} : Category one of these systems

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of zero sound mode despite having (e) a non-Fermi liquid type behavior of the specific heat

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

Authors find that these systems exhibit a zero sound mode despite having (e) a non-Fermi liquid type behavior of the specific heat

G_{28} : Category one of **these systems exhibit a zero sound mode despite;** non-Fermi liquid type behavior of the specific heat

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of non-Fermi liquid type behavior of the specific heat; **these systems exhibit a zero sound mode despite**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

These properties suggest (eb) that holography identifies (eb) a new type of quantum liquids

G_{32} : Category one of These properties

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of holography identifies (eb) a new type of quantum liquids

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

These properties suggest that holography identifies (eb) a new type of quantum liquids

G_{36} : Category one of **These properties suggest that holography identifies;** new type of quantum liquids

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of new type of quantum liquids **;These properties suggest that holography identifies**

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

Zero Sound From **Holography-**

G_{40} : Category one of Zero Sound; **Holography**

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of **Holography** ;Zero Sound

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

G_{44} : Category one of **Holography;** non-Fermi liquid type behavior of the specific heat

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of non-Fermi liquid type behavior of the specific heat; **Holography**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right]G_{13}$	1

$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23

$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)} \left((G_{27}), t \right) \right] T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25}, t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}), t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}, t) \right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}, t) \right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}, t) \right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} \left((G_{31}), t \right) \right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} \left((G_{31}), t \right) \right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} \left((G_{31}), t \right) \right] T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29}, t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}), t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}, t) \right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}, t) \right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}, t) \right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} \left((G_{35}), t \right) \right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} \left((G_{35}), t \right) \right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} \left((G_{35}), t \right) \right] T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}, t) \right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}, t) \right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}, t) \right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} \left((G_{39}), t \right) \right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} \left((G_{39}), t \right) \right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} \left((G_{39}), t \right) \right] T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}, t) \right] G_{40}$	*43*

$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[\begin{matrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[\begin{matrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b'_{13})^{(1)}\boxed{-(b''_{13})^{(1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b'_{14})^{(1)}\boxed{-(b''_{14})^{(1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b'_{15})^{(1)}\boxed{-(b''_{15})^{(1)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)}\boxed{+(a''_{16})^{(2)}(T_{17},t)}\ \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}\ \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}\ \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}\ \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}\ \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}\ \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16}$	*61*

$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a_{17}')^{(2)} \boxed{+(a_{17}'')^{(2)}(T_{17},t)} \boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a_{18}')^{(2)} \boxed{+(a_{18}'')^{(2)}(T_{17},t)} \boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	63
Where $\boxed{+(a_{16}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{44}'')^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b_{16}')^{(2)} \boxed{-(b_{16}'')^{(2)}(G_{19},t)} \boxed{-(b_{13}'')^{(1,1,)}(G,t)} \boxed{-(b_{20}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b_{17}')^{(2)} \boxed{-(b_{17}'')^{(2)}(G_{19},t)} \boxed{-(b_{14}'')^{(1,1,)}(G,t)} \boxed{-(b_{21}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b_{18}')^{(2)} \boxed{-(b_{18}'')^{(2)}(G_{19},t)} \boxed{-(b_{15}'')^{(1,1,)}(G,t)} \boxed{-(b_{22}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18}$	66
where $\boxed{-(b_{16}'')^{(2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{13}'')^{(1,1,)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,)}(G,t)}$ are second detrition coefficients for category	

1,2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b_{36}'')^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b_{40}'')^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b_{44}'')^{(9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a_{20}')^{(3)}\boxed{+(a_{20}'')^{(3)}(T_{21},t)}\boxed{+(a_{16}'')^{(2,2,2)}(T_{17},t)}\boxed{+(a_{13}'')^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7)}(T_{37},t)}\boxed{+(a_{40}'')^{(8,8,8,8)}(T_{41},t)}\boxed{+(a_{44}'')^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20} \quad 67$$

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a_{21}')^{(3)}\boxed{+(a_{21}'')^{(3)}(T_{21},t)}\boxed{+(a_{17}'')^{(2,2,2)}(T_{17},t)}\boxed{+(a_{14}'')^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7)}(T_{37},t)}\boxed{+(a_{41}'')^{(8,8,8,8)}(T_{41},t)}\boxed{+(a_{45}'')^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21} \quad 68$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a_{22}')^{(3)}\boxed{+(a_{22}'')^{(3)}(T_{21},t)}\boxed{+(a_{18}'')^{(2,2,2)}(T_{17},t)}\boxed{+(a_{15}'')^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7)}(T_{37},t)}\boxed{+(a_{42}'')^{(8,8,8,8)}(T_{41},t)}\boxed{+(a_{46}'')^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22} \quad 69$$

$\boxed{+(a_{20}'')^{(3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}'')^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{36}'')^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation

coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)}\boxed{-(b''_{20})^{(3)}(G_{23},t)}\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \quad (70)$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)}\boxed{-(b''_{21})^{(3)}(G_{23},t)}\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \quad (71)$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)}\boxed{-(b''_{22})^{(3)}(G_{23},t)}\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \quad (72)$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[\begin{matrix} (a'_{24})^{(4)}\boxed{+(a''_{24})^{(4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{24} \quad (73)$$

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$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[\begin{array}{c} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{array}\right] G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[\begin{array}{c} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{array}\right] G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[\begin{array}{c} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{array}\right] T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[\begin{array}{c} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{array}\right] T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[\begin{array}{c} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{array}\right] T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients*

for category 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation	

coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[\begin{matrix}(b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\ \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{28}$	*82*
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[\begin{matrix}(b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\ \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{29}$	*83*
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[\begin{matrix}(b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\ \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{30}$	*84*
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}$ $-\left[\begin{matrix}(a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\ \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\ \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\ \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\ \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\ \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\ \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{32}$	*85*

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34} \quad 87$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34} \quad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \right] G_{13}$	*91*
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \right] G_{14}$	*92*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \right] G_{15}$	*93*
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3	

$+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)$ are eighth augmentation coefficient for 1,2,3 $+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt}=$ $(b_{36})^{(7)}T_{37}-\left[\begin{matrix}(b'_{36})^{(7)}\boxed{-(b''_{36})^{(7)}(G_{39},t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{13}$	94
$\frac{dT_{37}}{dt}=$ $(b_{37})^{(7)}T_{36}-\left[\begin{matrix}(b'_{37})^{(7)}\boxed{-(b''_{37})^{(7)}(G_{39},t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{14}$	
$\frac{dT_{38}}{dt}=$ $(b_{38})^{(7)}T_{37}-\left[\begin{matrix}(b'_{38})^{(7)}\boxed{-(b''_{38})^{(7)}(G_{39},t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{15}$	
Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3 $-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)$, $-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)$	

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

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$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13}$$ 96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$\frac{dT_{44}}{dt} =$

$(b_{44})^{(9)} T_{45} -$

$\begin{bmatrix} (b_{44}^{'})^{(9)} \boxed{-(b_{44}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$	
$\frac{dT_{45}}{dt} =$ $(b_{45})^{(9)}T_{44} - \begin{bmatrix} (b_{45}^{'})^{(9)} \boxed{-(b_{45}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{46}}{dt} =$ $(b_{46})^{(9)}T_{45} - \begin{bmatrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{15}$	
Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(1)}, \ (r_i)^{(1)}$:	*97*

$(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\|(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14} - T_{14}'\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G - G'\|\|e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	

$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty} (a_i'')^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty} (b_i'')^{(2)}((G_{19}),t) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19}) - (G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i')^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$	112

The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (r_i)^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	
$lim_{T_2 \to \infty} (a_i'')^{(3)} (T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty} (b_i'')^{(3)} (G_{23}, t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}', t) - (a_i'')^{(3)}(T_{21}, t)\| \leq (\hat{k}_{20})^{(3)} \|T_{21} - T_{21}'\| e^{-(\hat{M}_{20})^{(3)} t}$ $\|(b_i'')^{(3)}(G_{23}', t) - (b_i'')^{(3)}(G_{23}, t)\| < (\hat{k}_{20})^{(3)} \|\|G_{23} - G_{23}'\|\| e^{-(\hat{M}_{20})^{(3)} t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}', t)$ and $(a_i'')^{(3)}(T_{21}, t)$. (T_{21}', t) And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}} [(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}} [(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded.	117

Definition of $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}\big((G_{27}),t\big) \leq \ (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i^{''})^{(4)}\big((G_{27}),t\big) = \ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}\big((G_{27}),t\big)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\big[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\big]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}, i = 24,25,26$, satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (a_i)^{(4)} + (a_i^{'})^{(4)} + \ (\hat{A}_{24})^{(4)} + \ (\hat{P}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)} + (b_i^{'})^{(4)} + \ (\hat{B}_{24})^{(4)} + \ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded.	122

Definition of $(p_i)^{(5)}, \ (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}),t) \leq \ (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t) = \ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(5)}(T_{29}^{'},t) - (a_i^{''})^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}^{'}\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i^{''})^{(5)}((G_{31})^{'},t) - (b_i^{''})^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})^{'}\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and $(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}} \ , \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and \ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i^{'})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)} + (a_i^{'})^{(5)} + \ (\hat{A}_{28})^{(5)} + \ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)} + (b_i^{'})^{(5)} + \ (\hat{B}_{28})^{(5)} + \ (\hat{Q}_{28})^{(5)}\ \ (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i^{'})^{(6)}, (a_i^{''})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (b_i^{''})^{(6)} > 0, \quad i,j = 32,33,34$	127

The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, \ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \leq \ (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2 \to \infty} (a_i'')^{(6)} (T_{33}, t) = (p_i)^{(6)}$ $\lim_{G \to \infty} (b_i'')^{(6)} \left((G_{35}), t\right) = \ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)} t}$ $\lvert(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}\left((G_{35}), t\right)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}} [\ (a_i)^{(6)} + (a_i')^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}} [\ (b_i)^{(6)} + (b_i')^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)} \ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	

(KK) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (LL) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39}, t) \leq \ (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(MM) $\lim_{T_2 \to \infty} (a_i^{''})^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(NN)* $\lim_{G \to \infty} (b_i^{''})^{(7)} \left((G_{39}), t\right) = \ (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(7)}(T_{37}^{'}, t) - (a_i^{''})^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}^{'}\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i^{''})^{(7)}((G_{39})^{'}, t) - (b_i^{''})^{(7)}\left((G_{39}), t\right)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})^{'}\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'}, t)$ and $(a_i^{''})^{(7)}(T_{37}, t)$. $(T_{37}^{'}, t)$ and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (OO) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (PP) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and \ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[\ (a_i)^{(7)} + (a_i^{'})^{(7)} + \ (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} \ (\hat{k}_{36})^{(7)}] < 1$	135

$\frac{1}{(\hat{M}_{36})^{(7)}}[\ (b_i)^{(7)}+(b_i')^{(7)}+\ (\hat{B}_{36})^{(7)}+(\hat{Q}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}]<1$	
Where we suppose	
$(a_i)^{(8)},(a_i')^{(8)},(a_i'')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(b_i'')^{(8)}>0,\quad i,j=40,41,42$	136
The functions $(a_i'')^{(8)},(b_i'')^{(8)}$ are positive continuous increasing and bounded	
<u>Definition of</u> $(p_i)^{(8)},\ (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41},t)\leq(p_i)^{(8)}\leq(\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}),t)\leq\ (r_i)^{(8)}\leq(b_i')^{(8)}\leq(\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i'')^{(8)}(T_{41},t)=(p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i'')^{(8)}\left((G_{43}),t\right)=\ (r_i)^{(8)}$	141
<u>Definition of</u> $(\hat{A}_{40})^{(8)},(\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)},(\hat{B}_{40})^{(8)},(p_i)^{(8)},\ (r_i)^{(8)}}$ are positive constants and $\boxed{i=40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t)-(a_i'')^{(8)}(T_{41},t)\rvert\leq(\hat{k}_{40})^{(8)}\lvert T_{41}-T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})',t)-(b_i'')^{(8)}\left((G_{43}),t\right)\rvert<(\hat{k}_{40})^{(8)}\lvert\lvert(G_{43})-(G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)}=1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},$ are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\ ,\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}<1$	144
<u>Definition of</u> $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)},\ (r_i)^{(8)},i=40,41,42,$	

Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i')^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t)\le(p_i)^{(9)}\le(\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t)\le(r_i)^{(9)}\le(b_i')^{(9)}\le(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t)=(r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $\boxed{(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)},(r_i)^{(9)}}$ are positive constants and $\boxed{i=44,45,46}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)\rvert\le(\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}'\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)\rvert<(\hat{k}_{44})^{(9)}\lvert\lvert(G_{47})-(G_{47})'\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with	

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities $\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)} (\hat{k}_{44})^{(9)}] < 1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)} (\hat{k}_{44})^{(9)}] < 1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	149
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Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions	152

Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	

$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}\left(T_{14}\left(s_{(13)}\right), s_{(13)}\right)\right) G_{15}\left(s_{(13)}\right)\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}\left(s_{(13)}\right) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}\left(G\left(s_{(13)}\right), s_{(13)}\right)\right) T_{13}\left(s_{(13)}\right)\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}\left(s_{(13)}\right) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}\left(G\left(s_{(13)}\right), s_{(13)}\right)\right) T_{14}\left(s_{(13)}\right)\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}\left(s_{(13)}\right) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}\left(G\left(s_{(13)}\right), s_{(13)}\right)\right) T_{15}\left(s_{(13)}\right)\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{16})^{(2)}, T_i^0 \leq (\hat{Q}_{16})^{(2)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(16)}\right)\right) G_{16}\left(s_{(16)}\right)\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}\left(s_{(16)}\right) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(17)}\right)\right) G_{17}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(16)}\right)\right) G_{18}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{16}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}\left(s_{(16)}\right) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{17}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{18}\left(s_{(16)}\right)\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{20}(s_{(20)}) \right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{22}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{20}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{\mathrm{T}}_{22}(\mathrm{t}) = \mathrm{T}_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{22}(s_{(20)}) \right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{\mathrm{T}}_{26}(\mathrm{t}) = \mathrm{T}_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to$	

$\mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \ , \ T_i(0) = T_i^0 \ , \ G_i^0 \leq (\ \hat{P}_{28}\ )^{(5)} \ , T_i^0 \leq (\ \hat{Q}_{28}\ )^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{28}\ )^{(5)} e^{(\ \hat{M}_{28}\ )^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{28}\ )^{(5)} e^{(\ \hat{M}_{28}\ )^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i\ , \ T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \ , \ T_i(0) = T_i^0 \ , \ G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)} \ , T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	

$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{36})^{(7)}, T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$, $T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a'_{44})^{(9)} + a''_{44})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a'_{45})^{(9)} + (a''_{45})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a'_{46})^{(9)} + (a''_{46})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{46}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b'_{44})^{(9)} - (b''_{44})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b'_{45})^{(9)} - (b''_{45})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b'_{46})^{(9)} - (b''_{46})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{46}(s_{(44)}) \right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	

The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1+(a_{13})^{(1)}t\right)G_{14}^0 + \frac{(a_{13})^{(1)}(\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left(e^{(\hat{M}_{13})^{(1)}t}-1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0 \right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0} \right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}} \right) \right] ds_{(16)} =$ $\left(1+(a_{16})^{(2)}t\right)G_{17}^0 + \frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t}-1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0 \right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0} \right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$	
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From which it follows that 174

$$(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[((\hat{P}_{24})^{(4)}+G_{25}^0)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$$

(G_i^0) is as defined in the statement of theorem 4

The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that

$$G_{28}(t) \leq G_{28}^0+\int_0^t\left[(a_{28})^{(5)}\left(G_{29}^0+(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\right)\right]ds_{(28)}=$$

$$\left(1+(a_{28})^{(5)}t\right)G_{29}^0+\frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t}-1\right)$$

From which it follows that 175

$$(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[((\hat{P}_{28})^{(5)}+G_{29}^0)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)}+(\hat{P}_{28})^{(5)}\right]$$

(G_i^0) is as defined in the statement of theorem 5

The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 176

$$G_{32}(t) \leq G_{32}^0+\int_0^t\left[(a_{32})^{(6)}\left(G_{33}^0+(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}s_{(32)}}\right)\right]ds_{(32)}=$$

$$\left(1+(a_{32})^{(6)}t\right)G_{33}^0+\frac{(a_{32})^{(6)}(\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left(e^{(\hat{M}_{32})^{(6)}t}-1\right)$$

From which it follows that 177

$$(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[((\hat{P}_{32})^{(6)}+G_{33}^0)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$$

(G_i^0) is as defined in the statement of theorem 6

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$$G_{36}(t) \leq G_{36}^0+\int_0^t\left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right]ds_{(36)}=$$

$$\left(1+(a_{36})^{(7)}t\right)G_{37}^0+\frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$$

From which it follows that

$(G_{36}(t) - G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
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From which it follows that $(G_{44}(t) - G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)} + G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)} + (\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45} , $G_{46}, T_{44}, T_{45}, T_{46}$	
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$$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[((\hat{Q}_{36})^{(7)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{36})^{(7)}\right]\leq(\hat{Q}_{36})^{(7)}$$

In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself

The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric 258

$$d\left(((G_{39})^{(1)},(T_{39})^{(1)}),((G_{39})^{(2)},(T_{39})^{(2)})\right)=$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}|G_i^{(1)}(t)-G_i^{(2)}(t)|e^{-(\hat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}|T_i^{(1)}(t)-T_i^{(2)}(t)|e^{-(\hat{M}_{36})^{(7)}t}\}$$

Indeed if we denote

<u>**Definition of**</u> $\widetilde{(G_{39})},\widetilde{(T_{39})}:\left(\widetilde{(G_{39})},\widetilde{(T_{39})}\right)=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$

It results

$$|\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}|\leq\int_0^t(a_{36})^{(7)}|G_{37}^{(1)}-G_{37}^{(2)}|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}ds_{(36)}+$$
$$\int_0^t\{(a'_{36})^{(7)}|G_{36}^{(1)}-G_{36}^{(2)}|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{-(\hat{M}_{36})^{(7)}s_{(36)}}+$$
$$(a''_{36})^{(7)}(T_{37}^{(1)},s_{(36)})|G_{36}^{(1)}-G_{36}^{(2)}|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}+$$
$$G_{36}^{(2)}|(a''_{36})^{(7)}(T_{37}^{(1)},s_{(36)})-(a''_{36})^{(7)}(T_{37}^{(2)},s_{(36)})|\ e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$$

Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on it follows

$$|(G_{39})^{(1)}-(G_{39})^{(2)}|e^{-(\hat{M}_{36})^{(7)}t}\leq$$ 259
$$\frac{1}{(\hat{M}_{36})^{(7)}}\left((a_{36})^{(7)}+(a'_{36})^{(7)}+(\hat{A}_{36})^{(7)}+(\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}\right)d\left(((G_{39})^{(1)},(T_{39})^{(1)};\ (G_{39})^{(2)},(T_{39})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

<u>**Remark 31:**</u> The fact that we supposed $(a''_{36})^{(7)}$ and $(b''_{36})^{(7)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$ *and* $(\hat{Q}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$ respectively of $\mathbb{R}_+$. 260

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it

suffices to consider that $(a_i^{''})^{(7)}$ and $(b_i^{''})^{(7)}, i = 36,37,38$ depend only on T_{37} and respectively on $(G_{39})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 32: There does not exist any t where $G_i(t) = 0\ and\ T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(7)} - (a_i^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\} ds_{(36)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(7)} t)} > 0$ for $t > 0$	261
Definition of $((\widehat{M}_{36})^{(7)})_1, ((\widehat{M}_{36})^{(7)})_2\ and\ ((\widehat{M}_{36})^{(7)})_3$: **Remark 33:** if G_{36} is bounded, the same property have also $G_{37}\ and\ G_{38}$. indeed if $G_{36} < (\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt} \leq ((\widehat{M}_{36})^{(7)})_1 - (a_{37}^{'})^{(7)} G_{37}$ and by integrating $G_{37} \leq ((\widehat{M}_{36})^{(7)})_2 = G_{37}^0 + 2(a_{37})^{(7)}((\widehat{M}_{36})^{(7)})_1/(a_{37}^{'})^{(7)}$ In the same way , one can obtain $G_{38} \leq ((\widehat{M}_{36})^{(7)})_3 = G_{38}^0 + 2(a_{38})^{(7)}((\widehat{M}_{36})^{(7)})_2/(a_{38}^{'})^{(7)}$ If $G_{37}\ or\ G_{38}$ is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.	262
Remark 34: If G_{36} *is* bounded, from below, the same property holds for $G_{37}\ and\ G_{38}$. The proof is analogous with the preceding one. An analogous property is true if G_{37} is bounded from below.	263
Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(7)}((G_{39})(t), t)) = (b_{37}^{'})^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i^{''})^{(7)}((G_{39})(t), t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$	264
Then $\frac{dT_{37}}{dt} \geq (a_{37})^{(7)}(m)^{(7)} - \varepsilon_7 T_{37}$ which leads to $T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{\varepsilon_7}\right)(1 - e^{-\varepsilon_7 t}) + T_{37}^0 e^{-\varepsilon_7 t}$ If we take t such that $e^{-\varepsilon_7 t} = \frac{1}{2}$ it results $T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{2}\right), \quad t = log\frac{2}{\varepsilon_7}$ By taking now ε_7 sufficiently small one sees that T_{37} is unbounded. The same property holds for T_{38} if $\lim_{t\to\infty}(b_{38}^{''})^{(7)}\left((G_{39})(t), t\right) = (b_{38}^{'})^{(7)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	265

It is now sufficient to take $\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}$, $\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$ and to choose ($\hat{P}_{40}$)$^{(8)}$ and ($\hat{Q}_{40}$)$^{(8)}$ large to have	266
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)}+((\hat{P}_{40})^{(8)}+G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{Q}_{40})^{(8)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right] \leq (\hat{Q}_{40})^{(8)}$	268
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **<u>Definition of</u>** $\widetilde{(G_{43})},\widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})},\widetilde{(T_{43})}\right)=\mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results $\left\|\tilde{G}_{40}^{(1)}-\tilde{G}_i^{(2)}\right\| \leq \int_0^t (a_{40})^{(8)}\left\|G_{41}^{(1)}-G_{41}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\,ds_{(40)}+$ $\int_0^t\{(a'_{40})^{(8)}\left\|G_{40}^{(1)}-G_{40}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{-(\hat{M}_{40})^{(8)}s_{(40)}}+$ $(a''_{40})^{(8)}(T_{41}^{(1)},s_{(40)})\left\|G_{40}^{(1)}-G_{40}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}+$ $G_{40}^{(2)}\|(a''_{40})^{(8)}(T_{41}^{(1)},s_{(40)})-(a''_{40})^{(8)}(T_{41}^{(2)},s_{(40)})\|\ e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\}ds_{(40)}$	271
Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
$\left\|(G_{43})^{(1)}-(G_{43})^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}t} \leq$ $\frac{1}{(\hat{M}_{40})^{(8)}}\left((a_{40})^{(8)}+(a'_{40})^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}\right)d\left(\left((G_{43})^{(1)},(T_{43})^{(1)};\ (G_{43})^{(2)},(T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
<u>Remark 36:</u> The fact that we supposed $(a''_{40})^{(8)}$ and $(b''_{40})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate	274

condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ *and* $(\hat{Q}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on $(G_{43})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 37 There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)}-(a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for t > 0	275
Definition of $\left((\hat{M}_{40})^{(8)}\right)_1, \left((\hat{M}_{40})^{(8)}\right)_2$ *and* $\left((\hat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\hat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\hat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)}G_{41}$ and by integrating $G_{41} \leq \left((\hat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\hat{M}_{40})^{(8)}\right)_1/(a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\hat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\hat{M}_{40})^{(8)}\right)_2/(a_{42}')^{(8)}$ If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	276
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\left((G_{43})(t),t\right) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results	279

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b''_{42})^{(8)}\left((G_{43})(t), t(t), t\right) = (b'_{42})^{(8)}$

It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + \left((\widehat{P}_{44})^{(9)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[\left((\widehat{Q}_{44})^{(9)} + T_j^0\right)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

<u>**Definition of**</u> $\widetilde{(G_{47})}, \widetilde{(T_{47})} : \left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}), (T_{47})\right)$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t\{(a'_{44})^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)|\; e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

<u>**Remark 41:**</u> The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)}G_{45}$ and by integrating

$$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \le -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \le -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \le -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G, t) - (b_{14}^{''})^{(1)}(G, t) \le -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)},\ if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)},\ if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)},\ if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \le G_{13}(t) \le G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
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$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)},\ \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)},$ and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
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$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
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$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}\left((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)}\right)}\left[e^{\left((S_1)^{(2)} - (p_{16})^{(2)}\right)t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}\left((S_1)^{(2)} - (a_{18}')^{(2)}\right)}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
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$\frac{(a_{18})^{(2)} T_{16}^{0}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^{0} e^{-(R_2)^{(2)}t}$	
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Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a'_{20})^{(3)} + (a'_{21})^{(3)} - (a''_{20})^{(3)}(T_{21}, t) + (a''_{21})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b'_{20})^{(3)} + (b'_{21})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) - (b''_{21})^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
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and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}, \ \boldsymbol{if} \ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if} \ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}, \ \boldsymbol{if} \ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)} t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)} t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})} \left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)} t} \right] + G_{22}^0 e^{-(S_2)^{(3)} t} \leq G_{22}(t) \leq \right.$ $\left. \frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a_{22}')^{(3)})} [e^{(S_1)^{(3)} t} - e^{-(a_{22}')^{(3)} t}] + G_{22}^0 e^{-(a_{22}')^{(3)} t} \right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)} t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)} t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
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<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)} (m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)} (\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
<u>**Behavior of the solutions of equation**</u> <u>**Theorem:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}\big((G_{27}),t\big) - (b_{25}'')^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
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and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \le T_{24}(t) \le T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \le T_{24}(t) \le \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \le T_{26}(t) \le$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \le -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \le -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \le -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\left((G_{31}), t\right) - (b_{29}'')^{(5)}\left((G_{31}), t\right) \le -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0, (\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0, (u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,	340

and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}, \ \boldsymbol{if} \ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}, \boldsymbol{if} \ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if} \ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$:

$(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying

$$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$$

$$-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \leq -(\tau_1)^{(6)}$$

Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: 350

By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$
and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and

Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: 351

By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$
and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$

Definition of $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:-

If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by

$(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)} < (\nu_1)^{(6)}$

$(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if}\ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$,
and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$

$(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$

and analogously 352

$(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$

$(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$,
and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$

$(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$

Then the solution of global equations satisfies the inequalities 353

$$G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)} t}$$

where $(p_i)^{(6)}$ is defined by equation

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ (a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b'_{34})^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b'_{34})^{(6)}t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a'_{32})^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b'_{32})^{(6)}$ $(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}((G_{39}), t) - (b''_{37})^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the	362

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **<u>Definition of</u>** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)},\ \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq \frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}^{'})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)}$ $(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} - (a_{40}^{''})^{(8)}(T_{41}, t) + (a_{41}^{''})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (b_{40}^{''})^{(8)}\big((G_{43}), t\big) - (b_{41}^{''})^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}, \textbf{\textit{if}}\ (\nu_0)^{(8)} < (\nu_1)^{(8)}$	

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, $\boldsymbol{if}$ $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}$ $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}$ $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)} t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)} t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)})} \left[e^{((S_1)^{(8)} - (p_{40})^{(8)})t} - e^{-(S_2)^{(8)} t} \right] + G_{42}^0 e^{-(S_2)^{(8)} t} \leq G_{42}(t) \leq \right.$ $\left. \frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)} - (a'_{42})^{(8)})} [e^{(S_1)^{(8)} t} - e^{-(a'_{42})^{(8)} t}] + G_{42}^0 e^{-(a'_{42})^{(8)} t} \right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)} - (b'_{42})^{(8)})} \left[e^{(R_1)^{(8)} t} - e^{-(b'_{42})^{(8)} t} \right] + T_{42}^0 e^{-(b'_{42})^{(8)} t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)} + (r_{40})^{(8)} + (R_2)^{(8)})} \left[e^{((R_1)^{(8)} + (r_{40})^{(8)})t} - e^{-(R_2)^{(8)} t} \right] + T_{42}^0 e^{-(R_2)^{(8)} t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)} (m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$

$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^{0} e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^{0} e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^{0} e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^{0} e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^{0}}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^{0} e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} G_{44}^{0}}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^{0} e^{-(a_{46}')^{(9)}t} \Big)$$

$$\boxed{T_{44}^{0} e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^{0} e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^{0} e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^{0} e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^{0}}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^{0} e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^{0}}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^{0} e^{-(R_2)^{(9)}t}$$

<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

<u>**Proof :**</u> From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14}, t) \right) - (a_{14}'')^{(1)}(T_{14}, t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

<u>**Definition of**</u> $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} \right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} \right)$$

From which one obtains

<u>**Definition of**</u> $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have <u>**Definition of**</u> $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain <u>**Definition of**</u> $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	386

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \le \frac{d\nu^{(2)}}{dt} \le -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \ge \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \le \nu^{(2)}(t) \le (\nu_1)^{(2)}$

In the same manner , we get 391

$$\nu^{(2)}(t) \le \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$$

From which we deduce $(\nu_0)^{(2)} \le \nu^{(2)}(t) \le (\bar{\nu}_1)^{(2)}$ 392

If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, 393

$$(\nu_1)^{(2)} \le \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}} \le \nu^{(2)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \le (\bar{\nu}_1)^{(2)}$$

If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}, \quad \boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
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Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
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Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)}=\frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)}=\frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$$

Definition of $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t)=\frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t)=\frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
Proof : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **Definition of** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
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If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G^0_{28}}{G^0_{29}}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}$, $\boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>**Particular case :**</u>

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

<u>**Proof**</u> : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right) - (a_{33}'')^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

<u>**Definition of**</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)},\quad\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)},\quad\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**
Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then
$(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

Proof : From global equations we obtain 416

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{36}'')^{(7)} = (a_{37}'')^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b_{36}'')^{(7)} = (b_{37}'')^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have
Definition of $\nu^{(8)}(t)$:-

$$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}, \quad \boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$$

In a completely analogous way, we obtain
Definition of $u^{(8)}(t)$:-

$$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}, \quad \boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case** . Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.	
Proof : From 99,20,44,22,23,44 we obtain $$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get $$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$ From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$	
If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case, $$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$ $$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$	

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain $(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(9)}(t)$:- $(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(9)}(t)$:- $(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$ Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem. **Particular case :** If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case** . Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.	
We can prove the following **Theorem** : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations $(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$ $(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$ $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ *with* $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	425
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429

$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-(b_{16}^{'})^{(2)}(r_{17})^{(2)}-(b_{17}^{'})^{(2)}(r_{17})^{(2)}+(r_{16})^{(2)}(r_{17})^{(2)}<0$ $with\ (p_{16})^{(2)},(r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}<0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}+(a_{20})^{(3)}(p_{20})^{(3)}+(a_{21}^{'})^{(3)}(p_{21})^{(3)}+(p_{20})^{(3)}(p_{21})^{(3)}>0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}>0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-(b_{20}^{'})^{(3)}(r_{21})^{(3)}-(b_{21}^{'})^{(3)}(r_{21})^{(3)}+(r_{20})^{(3)}(r_{21})^{(3)}<0$ $with\ (p_{20})^{(3)},(r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}<0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}+(a_{24})^{(4)}(p_{24})^{(4)}+(a_{25}^{'})^{(4)}(p_{25})^{(4)}+(p_{24})^{(4)}(p_{25})^{(4)}>0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}>0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-(b_{24}^{'})^{(4)}(r_{25})^{(4)}-(b_{25}^{'})^{(4)}(r_{25})^{(4)}+(r_{24})^{(4)}(r_{25})^{(4)}<0$ $with\ (p_{24})^{(4)},(r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}<0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}+(a_{28})^{(5)}(p_{28})^{(5)}+(a_{29}^{'})^{(5)}(p_{29})^{(5)}+(p_{28})^{(5)}(p_{29})^{(5)}>0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}>0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-(b_{28}^{'})^{(5)}(r_{29})^{(5)}-(b_{29}^{'})^{(5)}(r_{29})^{(5)}+(r_{28})^{(5)}(r_{29})^{(5)}<0$ $with\ (p_{28})^{(5)},(r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}<0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}+(a_{32})^{(6)}(p_{32})^{(6)}+(a_{33}^{'})^{(6)}(p_{33})^{(6)}+(p_{32})^{(6)}(p_{33})^{(6)}>0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}>0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-(b_{32}^{'})^{(6)}(r_{33})^{(6)}-(b_{33}^{'})^{(6)}(r_{33})^{(6)}+(r_{32})^{(6)}(r_{33})^{(6)}<0$	434

with $(p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ *with* $(p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ *with* $(p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ *with* $(p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (g) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
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Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^* for which $f(T_{17}^*)=0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^*)]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^*)]}$	495
Definition and uniqueness of T_{21}^* :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^* for which $f(T_{21}^*)=0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^*)]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^*)]}$	496
Definition and uniqueness of T_{25}^* :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^* for which $f(T_{25}^*)=0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^*)]}$	497
Definition and uniqueness of T_{29}^* :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^* for which $f(T_{29}^*)=0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^*)]}$	498
Definition and uniqueness of T_{33}^* :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^* for which $f(T_{33}^*)=0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^*)]}$	499
Definition and uniqueness of T_{37}^* :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*)=0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^*)]}$	500

Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right]+(b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
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Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	504
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By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{25} such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{29} such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{33} such that $\varphi({G_{35}}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{37} such that $\varphi({G_{39}}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi({G_{43}}^*) = 0$	510
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Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}')^{(8)} - (b_{40}'')^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}')^{(8)} - (b_{42}'')^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
<u>Proof:</u> Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*}) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}'')^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i'')^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}')^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}')^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}')^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}')^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}')^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}')^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(5)}$ *and* $(b_i'')^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}'')^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i'')^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G^*_{38}\,\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T^*_{36}\,\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T^*_{37}\,\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T^*_{38}\,\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **<u>Theorem 8:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}}(T^*_{41}) = (q_{41})^{(8)} \;,\; \frac{\partial (b''_i)^{(8)}}{\partial G_j}((G_{43})^*) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G^*_{40}\,\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G^*_{41}\,\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)} G^*_{42}\,\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)} T^*_{40}\,\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)} T^*_{41}\,\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)} T^*_{42}\,\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(9)}$ *and* $(b''_i)^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}} (T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j} ((G_{47})^*) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)} G_{44}^* \mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)} G_{45}^* \mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)} G_{46}^* \mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)} T_{44}^* \mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)} T_{45}^* \mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)} T_{46}^* \mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^* + (b_{14})^{(1)}s_{(13),(13)}T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)}G_{15}$ $+\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right) \left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$ +	

$$\left((\lambda)^{(2)}+(b_{18}')^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}')^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}')^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}')^{(2)}+(b_{17}')^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(3)}+(b_{22}')^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}')^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$$

$$+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$$

+

$((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(((\lambda)^{(4)})^{2}+((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^{2}+((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)})(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^{2}+((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ $+$	
$((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(((\lambda)^{(5)})^{2}+((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^{2}+((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)})(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^{2}+((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$ $+$	

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$((\lambda)^{(8)} + (b'_{42})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a'_{42})^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(q_{40})^{(8)}G^*_{40}\right)\right]$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T^*_{41} + (b_{41})^{(8)}s_{(40),(41)}T^*_{41}\right)$$

$$+\left(((\lambda)^{(8)} + (a'_{41})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G^*_{40} + (a_{40})^{(8)}(q_{41})^{(8)}G^*_{41}\right)$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T^*_{41} + (b_{41})^{(8)}s_{(40),(40)}T^*_{40}\right)$$

$$\left(((\lambda)^{(8)})^2 + \left((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(((\lambda)^{(8)})^2 + \left((b'_{40})^{(8)} + (b'_{41})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(((\lambda)^{(8)})^2 + \left((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G^*_{40}\right)$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T^*_{41} + (b_{41})^{(8)}s_{(40),(42)}T^*_{40}\right)\} = 0$$

$+$

$$((\lambda)^{(9)} + (b'_{46})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a'_{46})^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(q_{44})^{(9)}G^*_{44}\right)\right]$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T^*_{45} + (b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$$

$$+\left(((\lambda)^{(9)} + (a'_{45})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G^*_{44} + (a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T^*_{45} + (b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$$

$$\left(((\lambda)^{(9)})^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(((\lambda)^{(9)})^2 + \left((b'_{44})^{(9)} + (b'_{45})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(((\lambda)^{(9)})^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T^*_{45} + (b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\} = 0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**	

SECTION EIGHT

Relativistic Viscous Hydrodynamics, Conformal Invariance, And Holography

INTRODUCTION—VARIABLES USED

Relativistic viscous hydrodynamics, conformal invariance, and holography R. Baier, P. Romatschke, D. T. Son, A. O. Starinets, M. A. Stephanov

(1) Authors consider second-order viscous hydrodynamics in (eb) conformal field theories at (eb) finite temperature.
(2) They show that conformal invariance imposes (e&eb) powerful constraints on (e&eb) the form of the second-order corrections.
(3) By matching to (e) the AdS/CFT calculations of correlators, and to (e) recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory.
(4) Authors also discuss how these new coefficents can arise within (eb) the kinetic theory of weakly coupled conformal plasmas.
(5) They point out that the Mueller-Israel-Stewart theory, often used in (eb) numerical simulations, does not contain (e) all allowed second-order terms and, frequently, terms required by (e) conformal invariance. Subjects: High Energy Physics - Theory (hep-th); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) Journal reference: JHEP0804:100,2008 DOI: 10.1088/1126-6708/2008/04/100 Report number: BI-TP 2007/29, INT PUB 07-45, SHEP-07-47 Cite as: arXiv:0712.2451 [hep-th] (or arXiv:0712.2451v3 [hep-th] for this version)

Holographic spectral functions and diffusion constants for fundamental matter; Robert C. Myers, Andrei O. Starinets, Rowan M. Thomson

(6) The holographic dual of large-Nc super-Yang-Mills coupled to (e&eb) a small number of flavours of fundamental matter, Nf << Nc, is described by (e) Nf probe D7-branes in (eb) the gravitational background of Nc black D3-branes.
(7) This system undergoes a first order phase transition characterised by (e&eb) the `melting' of (e) the mesons.
(8) Authors study the high temperature phase in which the D7-branes extend through (e&eb) the black hole horizon.
(9) In this phase, authors compute the spectral function for vector, scalar and pseudoscalar modes on (e&eb) the D7-brane probe.

(10) They also compute the diffusion constant for (e) the flavour currents. Subjects: High Energy Physics - Theory (hep-th) Journal reference: JHEP 0711:091,2007 DOI: 10.1088/1126-6708/2007/11/091 Cite as: arXiv:0706.0162 [hep-th] (or arXiv:0706.0162v3 [hep-th] for this version)

NOTATION

Module One

Authors consider second-order viscous hydrodynamics in (eb) conformal field theories at (eb) finite temperature

G_{13} : Category one of second-order viscous hydrodynamics; **conformal field theories at (eb) finite temperature**

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of **conformal field theories at (eb) finite temperature;** second-order viscous hydrodynamics

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Authors consider second-order viscous hydrodynamics in conformal field theories at (eb) finite temperature

G_{16} : Category one of second-order viscous hydrodynamics in conformal field theories; **) finite temperature**

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of **finite temperature** ;second-order viscous hydrodynamics in conformal field theories

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

They show that conformal invariance imposes (e&eb) powerful constraints on (e&eb) the form of the second-order corrections

G_{20} : Category one of **conformal invariance;** powerful constraints on (e&eb) the form of the second-order corrections

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of powerful constraints on (e&eb) the form of the second-order corrections **;conformal**

invariance

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

They show that conformal invariance imposes powerful constraints on (e&eb) the form of the second-order corrections

G_{24} : Category one of **conformal invariance imposes powerful constraints;** form of the second-order corrections

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of form of the second-order corrections **;conformal invariance imposes powerful constraints**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

By matching to (e) the AdS/CFT calculations of correlators, and to (e) recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory

G_{28} : Category one of **second-order corrections;** AdS/CFT calculations of correlators, and to (e) recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of AdS/CFT calculations of correlators, and to (e) recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory; **second-order corrections**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

By matching second-order corrections to the AdS/CFT calculations of correlators, and to (e) recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory

G_{32} : Category one of **second-order corrections to the AdS/CFT calculations of correlators;** recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory; **second-order corrections to the AdS/CFT calculations of correlators**

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

By matching second-order corrections to the AdS/CFT calculations of correlators, and to recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory

G_{36} : Category one of second-order corrections to the AdS/CFT calculations of correlators, and to recent results for Bjorken flow obtained by Heller and Janik

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

By matching second-order corrections to the AdS/CFT calculations of correlators, and to recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients in (eb) the strongly coupled N=4 supersymmetric Yang-Mills theory

G_{40} : Category one of matching second-order corrections to the AdS/CFT calculations of correlators, and to recent results for Bjorken flow obtained by Heller and Janik, they find three (out of five) second-order transport coefficients

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of strongly coupled N=4 supersymmetric Yang-Mills theory

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

Authors also discuss how these new coefficents can arise within (eb) the kinetic theory of weakly coupled conformal plasmas

G_{44} : Category one of **new coefficents can arise;** kinetic theory of weakly coupled conformal plasmas

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of kinetic theory of weakly coupled conformal plasmas **;new coefficents can arise**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)} (T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}, t) \right] G_{15}$	3

$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	

$-(b_{24}^{''})^{(4)}\big((G_{27}),t\big) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\big((G_{31}),t\big)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\big((G_{31}),t\big)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\big((G_{31}),t\big)\right]T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\big((G_{31}),t\big) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\big((G_{35}),t\big)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\big((G_{35}),t\big)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\big((G_{35}),t\big)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\big((G_{39}),t\big)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\big((G_{39}),t\big)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\big((G_{39}),t\big)\right]T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right]G_{41}$	*44*

$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}),t\right)\right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}),t\right)\right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}),t\right)\right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for	

1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\left[\begin{matrix}(b'_{13})^{(1)}\boxed{-(b''_{13})^{(1)}(G,t)}\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{13}$	58
$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[\begin{matrix}(b'_{14})^{(1)}\boxed{-(b''_{14})^{(1)}(G,t)}\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{14}$	59
$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[\begin{matrix}(b'_{15})^{(1)}\boxed{-(b''_{15})^{(1)}(G,t)}\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[\begin{matrix}(a'_{16})^{(2)}\boxed{+(a''_{16})^{(2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{16}$	*61*

$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category	

1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{20}$	*67*
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21}$	*68*
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22}$	*69*
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation	

coefficients for category 1, 2 and 3

$+(a''_{40})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3

$+(a''_{44})^{(9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b'_{20})^{(3)} -(b''_{20})^{(3)}(G_{23},t) - (b''_{16})^{(2,2,2)}(G_{19},t) - (b''_{13})^{(1,1,1,)}(G,t) \\ -(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{28})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{32})^{(6,6,6,6,6,6)}(G_{35},t) \\ - (b''_{36})^{(7,7,7,7)}(G_{39},t) - (b''_{40})^{(8,8,8,8)}(G_{43},t) - (b''_{44})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} -(b''_{21})^{(3)}(G_{23},t) - (b''_{17})^{(2,2,2)}(G_{19},t) - (b''_{14})^{(1,1,1,)}(G,t) \\ -(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{29})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{33})^{(6,6,6,6,6,6)}(G_{35},t) \\ - (b''_{37})^{(7,7,7,7)}(G_{39},t) - (b''_{41})^{(8,8,8,8)}(G_{43},t) - (b''_{45})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} -(b''_{22})^{(3)}(G_{23},t) - (b''_{18})^{(2,2,2)}(G_{19},t) - (b''_{15})^{(1,1,1,)}(G,t) \\ -(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{30})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{34})^{(6,6,6,6,6,6)}(G_{35},t) \\ - (b''_{38})^{(7,7,7,7)}(G_{39},t) - (b''_{42})^{(8,8,8,8)}(G_{43},t) - (b''_{46})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{22} \quad 72$$

$-(b''_{20})^{(3)}(G_{23},t)$, $-(b''_{21})^{(3)}(G_{23},t)$, $-(b''_{22})^{(3)}(G_{23},t)$ *are first detrition coefficients for category 1, 2 and 3*

$-(b''_{16})^{(2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2)}(G_{19},t)$ *are second detrition coefficients for category 1, 2 and 3*

$-(b''_{13})^{(1,1,1,)}(G,t)$, $-(b''_{14})^{(1,1,1,)}(G,t)$, $-(b''_{15})^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3*

$-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3*

$-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3*

$-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3*

$-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$ $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} +(a''_{24})^{(4)}(T_{25},t) +(a''_{28})^{(5,5,)}(T_{29},t) +(a''_{32})^{(6,6,)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1)}(T_{14},t) +(a''_{16})^{(2,2,2,2)}(T_{17},t) +(a''_{20})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{36})^{(7,7,7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8,8,8)}(T_{41},t) +(a''_{44})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients*

$for\ category$ 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category$ 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ $are\ fourth\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ $are\ fifth\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ $are\ sixth\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ $are\ seventh\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ $are\ eighth\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
$Where$ $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ $are\ first\ augmentation$ $coefficients\ for\ category$ 1, 2 and 3 And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ $are\ second\ augmentation$ $coefficient\ for\ category$ 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation$ $coefficient\ for\ category$ 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation	

coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[\begin{matrix}(b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\ \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{28}$	82
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[\begin{matrix}(b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\ \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{29}$	83
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[\begin{matrix}(b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\ \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{30}$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}$ $-\left[\begin{matrix}(a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\ \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\ \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{32}$	85

$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{33}$	86
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{34}$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}, \boxed{+(a''_{33})^{(6)}(T_{33},t)}, \boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}, \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}, \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}, \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}, \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}, \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}, \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{32}$	88
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{33}$	89
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{34}$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}, \boxed{-(b''_{33})^{(6)}(G_{35},t)}, \boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3	

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)}\boxed{+(a''_{36})^{(7)}(T_{37},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{13} \qquad 91$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)}\boxed{+(a''_{37})^{(7)}(T_{37},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{14} \qquad 92$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix} (a'_{38})^{(7)}\boxed{+(a''_{38})^{(7)}(T_{37},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{15} \qquad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)}\boxed{-(b''_{36})^{(7)}(G_{39},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13} \qquad 94$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)}\boxed{-(b''_{37})^{(7)}(G_{39},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)}\boxed{-(b''_{38})^{(7)}(G_{39},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} -(b''_{40})^{(8)}(G_{43},t) & -(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t) & -(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t) & -(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t) & -(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t) & -(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t) & -(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} -(b''_{41})^{(8)}(G_{43},t) & -(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t) & -(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t) & -(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t) & -(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t) & -(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t) & -(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} -(b''_{42})^{(8)}(G_{43},t) & -(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t) & -(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t) & -(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t) & -(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t) & -(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t) & -(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{15}$$

Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3

$-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3

$-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3

$-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3

$-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3

$-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)$ are sixth detrition coefficients for category 1, 2 and 3

$-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3

$-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13}$$ 96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$\frac{dT_{44}}{dt} =$

$(b_{44})^{(9)} T_{45} -$

$\begin{bmatrix} (b_{44}^{'})^{(9)} \boxed{-(b_{44}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$	
$\frac{dT_{45}}{dt} =$ $(b_{45})^{(9)}T_{44} - \begin{bmatrix} (b_{45}^{'})^{(9)} \boxed{-(b_{45}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{46}}{dt} =$ $(b_{46})^{(9)}T_{45} - \begin{bmatrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{15}$	
Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(1)}, \ (r_i)^{(1)}$:	97

$(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\lvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	

$(a_i^{''})^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i^{'})^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty} (a_i^{''})^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty} (b_i^{''})^{(2)}((G_{19}),t) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(2)}(T_{17}^{'},t) - (a_i^{''})^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}^{'}\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i^{''})^{(2)}((G_{19})^{'},t) - (b_i^{''})^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19}) - (G_{19})^{'}\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'},t)$ and $(a_i^{''})^{(2)}(T_{17},t)$. $(T_{17}^{'},t)$ and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i^{''})^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i^{'})^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i^{'})^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$	112

The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, (r_i)^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	
$lim_{T_2 \to \infty}(a_i'')^{(3)}(T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty}(b_i'')^{(3)}(G_{23}, t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}', t) - (a_i'')^{(3)}(T_{21}, t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}', t) - (b_i'')^{(3)}(G_{23}, t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}', t)$ and$(a_i'')^{(3)}(T_{21}, t)$. (T_{21}', t) And (T_{21}, t) are points belonging to the interval $[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i, j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded.	117

Definition of $(p_i)^{(4)}, \ (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t) \leq \ (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t) = \ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, \ (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\lvert(a_i'')^{(4)}(T_{25}',t) - (a_i'')^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i'')^{(4)}((G_{27})',t) - (b_i'')^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and $(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} \ , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and \ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (p_i)^{(4)}, \ (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (a_i)^{(4)} + (a_i')^{(4)} + \ (\hat{A}_{24})^{(4)} + \ (\hat{P}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)} + (b_i')^{(4)} + \ (\hat{B}_{24})^{(4)} + \ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i')^{(5)}, (a_i'')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (b_i'')^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i'')^{(5)}, (b_i'')^{(5)}$ are positive continuous increasing and bounded.	122

Definition of $(p_i)^{(5)}, \ (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}),t) \leq \ (r_i)^{(5)} \leq (b_i')^{(5)} \leq (\hat{B}_{28})^{(5)}$	
$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t) = \ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t) - (a_i'')^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t) - (b_i'')^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and $(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}} \ , \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and \ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)} + (a_i')^{(5)} + \ (\hat{A}_{28})^{(5)} + \ (\hat{P}_{28})^{(5)} \ (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)} + (b_i')^{(5)} + \ (\hat{B}_{28})^{(5)} + \ (\hat{Q}_{28})^{(5)} \ (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$	127

The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(6)}, \ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t) \leq \ (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2\to\infty}(a_i'')^{(6)}(T_{33},t) = (p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}\left((G_{35}),t\right) = \ (r_i)^{(6)}$ <u>**Definition of**</u> $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}',t) - (a_i'')^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)}\lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i'')^{(6)}((G_{35})',t) - (b_i'')^{(6)}\left((G_{35}),t\right)\rvert < (\hat{k}_{32})^{(6)}\lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}',t)$ and$(a_i'')^{(6)}(T_{33},t)$. (T_{33}',t) and (T_{33},t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>**Definition of**</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i')^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)}\ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i')^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)}\ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	

(QQ) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (RR) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39}, t) \leq \ (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(SS) $\lim_{T_2 \to \infty} (a_i^{''})^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(TT)* $\lim_{G \to \infty} (b_i^{''})^{(7)} \left((G_{39}), t\right) = \ (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(7)}(T_{37}^{'}, t) - (a_i^{''})^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}^{'}\rvert e^{-(\hat{M}_{36})^{(7)} t}$ $\lvert(b_i^{''})^{(7)}((G_{39})', t) - (b_i^{''})^{(7)}\left((G_{39}), t\right)\rvert < (\hat{k}_{36})^{(7)} \lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'}, t)$ and $(a_i^{''})^{(7)}(T_{37}, t)$. $(T_{37}^{'}, t)$ and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (UU) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (VV) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and \ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[\ (a_i)^{(7)} + (a_i^{'})^{(7)} + \ (\hat{A}_{36})^{(7)} + \ (\hat{P}_{36})^{(7)} \ (\hat{k}_{36})^{(7)}] < 1$	135

$\frac{1}{(\hat{M}_{36})^{(7)}}[\ (b_i)^{(7)} + (b_i')^{(7)} + \ (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}] < 1$	
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)},\ (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \le (p_i)^{(8)} \le (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}), t) \le\ (r_i)^{(8)} \le (b_i')^{(8)} \le (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i'')^{(8)}(T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i'')^{(8)}\big((G_{43}), t\big) = \ (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)},\ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t)\rvert \le (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})', t) - (b_i'')^{(8)}\big((G_{43}), t\big)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}', t)$ and $(a_i'')^{(8)}(T_{41}, t)$. (T_{41}', t) and (T_{41}, t) are points belonging to the interval $\big[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\big]$. It is to be noted that $(a_i'')^{(8)}(T_{41}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)},$ are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)},\ (r_i)^{(8)}, i = 40,41,42,$	

Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i')^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t)\le(p_i)^{(9)}\le(\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t)\le(r_i)^{(9)}\le(b_i')^{(9)}\le(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t)=(r_i)^{(9)}$ **<u>Definition of</u>** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $\boxed{(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}}$ are positive constants and $\boxed{i=44,45,46}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)\rvert\le(\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}'\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)\rvert<(\hat{k}_{44})^{(9)}\lvert\lvert(G_{47})-(G_{47})'\rvert\lvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
<u>Definition of</u> $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with	

$(\hat{\mathcal{M}}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities $$\frac{1}{(\hat{\mathcal{M}}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$ $$\frac{1}{(\hat{\mathcal{M}}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{\mathcal{M}}_{13})^{(1)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{\mathcal{M}}_{13})^{(1)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{\mathcal{M}}_{16})^{(2)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{\mathcal{M}}_{16})^{(2)} t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{\mathcal{M}}_{20})^{(3)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{\mathcal{M}}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{\mathcal{M}}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{\mathcal{M}}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{\mathcal{M}}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{\mathcal{M}}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions	152

Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
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$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)},$	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	

$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{20}(s_{(20)}) \right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{22}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{20}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{22}(s_{(20)}) \right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to$	

$\mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{28} \,)^{(5)} \, , T_i^0 \leq (\, \hat{Q}_{28} \,)^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{28} \,)^{(5)} e^{(\, \hat{M}_{28} \,)^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{28} \,)^{(5)} e^{(\, \hat{M}_{28} \,)^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{28}')^{(5)} + a_{28}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{28}\left(s_{(28)}\right)\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}\left(s_{(28)}\right) - \left((a_{29}')^{(5)} + (a_{29}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{29}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{30}')^{(5)} + (a_{30}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{30}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{28}')^{(5)} - (b_{28}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{28}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}\left(s_{(28)}\right) - \left((b_{29}')^{(5)} - (b_{29}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{29}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{30}')^{(5)} - (b_{30}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{30}\left(s_{(28)}\right)\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i \, , \, T_i \colon \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} \, , T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}\left(s_{(32)}\right) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{32}\left(s_{(32)}\right)\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}\left(s_{(32)}\right) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{33}\left(s_{(32)}\right)\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}\left(s_{(32)}\right) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{34}\left(s_{(32)}\right)\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}\left(s_{(32)}\right) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}\left(G_{35}\left(s_{(32)}\right), s_{(32)}\right)\right) T_{32}\left(s_{(32)}\right)\right] ds_{(32)}$	

$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{36})^{(7)}, T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	

The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1+(a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1+(a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1+(a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1\right)$	171
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$$d\left(\left((G_{27})^{(1)},(T_{27})^{(1)}\right),\left((G_{27})^{(2)},(T_{27})^{(2)}\right)\right)=$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\hat{M}_{24})^{(4)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\hat{M}_{24})^{(4)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{27})},\widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})},\widetilde{(T_{27})}\right)=\mathcal{A}^{(4)}((G_{27}),(T_{27}))$

It results

$$\left|\tilde{G}_{24}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{24})^{(4)}\left|G_{25}^{(1)}-G_{25}^{(2)}\right|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\,ds_{(24)}+$$

$$\int_0^t\{(a_{24}^{'})^{(4)}\left|G_{24}^{(1)}-G_{24}^{(2)}\right|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{-(\hat{M}_{24})^{(4)}s_{(24)}}+$$

$$(a_{24}^{''})^{(4)}\left(T_{25}^{(1)},s_{(24)}\right)\left|G_{24}^{(1)}-G_{24}^{(2)}\right|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}+$$

$$G_{24}^{(2)}|(a_{24}^{''})^{(4)}\left(T_{25}^{(1)},s_{(24)}\right)-(a_{24}^{''})^{(4)}\left(T_{25}^{(2)},s_{(24)}\right)|\;e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\}ds_{(24)}$$

Where $s_{(24)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on Equations it follows

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$$\frac{1}{(\hat{M}_{24})^{(4)}}\left((a_{24})^{(4)}+\,(a_{24}^{'})^{(4)}+(\hat{A}_{24})^{(4)}+(\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}\right)d\left(\left((G_{27})^{(1)},(T_{27})^{(1)};\;(G_{27})^{(2)},(T_{27})^{(2)}\right)\right)$$

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it results

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The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(((G_{39})^{(1)},(T_{39})^{(1)}),((G_{39})^{(2)},(T_{39})^{(2)})\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\|G_i^{(1)}(t)-G_i^{(2)}(t)\|e^{-(\hat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}\|T_i^{(1)}(t)-T_i^{(2)}(t)\|e^{-(\hat{M}_{36})^{(7)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{39})},\widetilde{(T_{39})}:(\widetilde{(G_{39})},\widetilde{(T_{39})})=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$ It results $\|\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}\|\leq\int_0^t(a_{36})^{(7)}\|G_{37}^{(1)}-G_{37}^{(2)}\|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}ds_{(36)}+$ $\int_0^t\{(a'_{36})^{(7)}\|G_{36}^{(1)}-G_{36}^{(2)}\|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{-(\hat{M}_{36})^{(7)}s_{(36)}}+$ $(a''_{36})^{(7)}(T_{37}^{(1)},s_{(36)})\|G_{36}^{(1)}-G_{36}^{(2)}\|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}+$ $G_{36}^{(2)}\|(a''_{36})^{(7)}(T_{37}^{(1)},s_{(36)})-(a''_{36})^{(7)}(T_{37}^{(2)},s_{(36)})\|\ e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\text{t}]$ From the hypotheses on it follows	258
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suffices to consider that $(a_i^{''})^{(7)}$ and $(b_i^{''})^{(7)}, i = 36,37,38$ depend only on T_{37} and respectively on $(G_{39})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 32: There does not exist any t where $G_i(t) = 0\ and\ T_i(t) = 0$ 261

it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(7)}-(a_i^{''})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\}ds_{(36)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(7)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{36})^{(7)}\right)_1, \left((\widehat{M}_{36})^{(7)}\right)_2\ and\ \left((\widehat{M}_{36})^{(7)}\right)_3$: 262

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$G_{36} < (\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt} \leq \left((\widehat{M}_{36})^{(7)}\right)_1 - (a_{37}^{'})^{(7)}G_{37}$ and by integrating

$$G_{37} \leq \left((\widehat{M}_{36})^{(7)}\right)_2 = G_{37}^0 + 2(a_{37})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_1/(a_{37}^{'})^{(7)}$$

In the same way , one can obtain

$$G_{38} \leq \left((\widehat{M}_{36})^{(7)}\right)_3 = G_{38}^0 + 2(a_{38})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_2/(a_{38}^{'})^{(7)}$$

If $G_{37}\ or\ G_{38}$ is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.

Remark 34: If G_{36} *is* bounded, from below, the same property holds for $G_{37}\ and\ G_{38}$. The proof is analogous with the preceding one. An analogous property is true if G_{37} is bounded from below. 263

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Definition of $(m)^{(7)}$ and ε_7 :

Indeed let t_7 be so that for $t > t_7$

$$(b_{37})^{(7)} - (b_i^{''})^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$$

Then $\frac{dT_{37}}{dt} \geq (a_{37})^{(7)}(m)^{(7)} - \varepsilon_7 T_{37}$ which leads to 265

$T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{\varepsilon_7}\right)(1 - e^{-\varepsilon_7 t}) + T_{37}^0 e^{-\varepsilon_7 t}$ If we take t such that $e^{-\varepsilon_7 t} = \frac{1}{2}$ it results

$T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{2}\right), \quad t = log\frac{2}{\varepsilon_7}$ By taking now ε_7 sufficiently small one sees that T_{37} is unbounded. The same property holds for T_{38} if $\lim_{t\to\infty}(b_{38}^{''})^{(7)}\left((G_{39})(t),t\right) = (b_{38}^{'})^{(7)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations

It is now sufficient to take $\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}$, $\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$ and to choose $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ large to have	266
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The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
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Indeed if we denote **Definition of** $\widetilde{(G_{43})}, \widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
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Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
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$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b''_{42})^{(8)}\left((G_{43})(t), t(t), t\right) = (b'_{42})^{(8)}$

It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + \left((\widehat{P}_{44})^{(9)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[\left((\widehat{Q}_{44})^{(9)} + T_j^0\right)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}), (T_{47})\right)$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t\{(a'_{44})^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)|\ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by

$(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for t} > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t), t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t), t) = (b_{46}')^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a'_{13})^{(1)} + (a'_{14})^{(1)} - (a''_{13})^{(1)}(T_{14}, t) + (a''_{14})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G, t) - (b''_{14})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})} \left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t} \right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq \right.$ $\left. \frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})} [e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}] + G_{15}^0 e^{-(a_{15}')^{(1)}t} \right)$	286
$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})} \left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t} \right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})} \left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t} \right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
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Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\big((G_{19}), t\big) - (b_{17}'')^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300

roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2+(\sigma_2)^{(2)}\nu^{(2)}-(a_{16})^{(2)}=0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2+(\tau_2)^{(2)}u^{(2)}-(b_{16})^{(2)}=0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)}=(\nu_0)^{(2)},(m_1)^{(2)}=(\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)}<(\nu_1)^{(2)}$	305
$(m_2)^{(2)}=(\nu_1)^{(2)},(m_1)^{(2)}=(\bar{\nu}_1)^{(2)},\boldsymbol{if}\ (\nu_1)^{(2)}<(\nu_0)^{(2)}<(\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)}=(\nu_1)^{(2)},(m_1)^{(2)}=(\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)}<(\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)}=(u_0)^{(2)},(\mu_1)^{(2)}=(u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)}<(u_1)^{(2)}$ $(\mu_2)^{(2)}=(u_1)^{(2)},(\mu_1)^{(2)}=(\bar{u}_1)^{(2)},\boldsymbol{if}\ (u_1)^{(2)}<(u_0)^{(2)}<(\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)}=\frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)}=(u_1)^{(2)},(\mu_1)^{(2)}=(u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)}<(u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t}\le G_{16}(t)\le G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}}G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t}\le G_{17}(t)\le\frac{1}{(m_2)^{(2)}}G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t}-e^{-(S_2)^{(2)}t}\right]+G_{18}^0e^{-(S_2)^{(2)}t}\le G_{18}(t)\le\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t}-e^{-(a_{18}')^{(2)}t}\right]+G_{18}^0e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0e^{(R_1)^{(2)}t}\le T_{16}(t)\le T_{16}^0e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}}T_{16}^0e^{(R_1)^{(2)}t}\le T_{16}(t)\le\frac{1}{(\mu_2)^{(2)}}T_{16}^0e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t}-e^{-(b_{18}')^{(2)}t}\right]+T_{18}^0e^{-(b_{18}')^{(2)}t}\le T_{18}(t)\le$	315

$\frac{(a_{18})^{(2)}\mathrm{T}_{16}^{0}}{(\mu_2)^{(2)}((\mathrm{R}_1)^{(2)}+(r_{16})^{(2)}+(\mathrm{R}_2)^{(2)})}\left[\mathrm{e}^{((\mathrm{R}_1)^{(2)}+(r_{16})^{(2)})t}-\mathrm{e}^{-(\mathrm{R}_2)^{(2)}t}\right]+\mathrm{T}_{18}^{0}\mathrm{e}^{-(\mathrm{R}_2)^{(2)}t}$	
Definition of $(\mathrm{S}_1)^{(2)},(\mathrm{S}_2)^{(2)},(\mathrm{R}_1)^{(2)},(\mathrm{R}_2)^{(2)}$:-	316
Where $(\mathrm{S}_1)^{(2)}=(a_{16})^{(2)}(m_2)^{(2)}-(a_{16}')^{(2)}$ $(\mathrm{S}_2)^{(2)}=(a_{18})^{(2)}-(p_{18})^{(2)}$	317
$(R_1)^{(2)}=(b_{16})^{(2)}(\mu_2)^{(1)}-(b_{16}')^{(2)}$ $(\mathrm{R}_2)^{(2)}=(b_{18}')^{(2)}-(r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)}\leq-(a_{20}')^{(3)}+(a_{21}')^{(3)}-(a_{20}'')^{(3)}(T_{21},t)+(a_{21}'')^{(3)}(T_{21},t)\leq-(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)}\leq-(b_{20}')^{(3)}+(b_{21}')^{(3)}-(b_{20}'')^{(3)}(G_{23},t)-(b_{21}'')^{(3)}((G_{23}),t)\leq-(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)},(\nu_2)^{(3)},(u_1)^{(3)},(u_2)^{(3)}$: By $(\nu_1)^{(3)}>0,(\nu_2)^{(3)}<0$ and respectively $(u_1)^{(3)}>0,(u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_1)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_1)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$ and By $(\bar{\nu}_1)^{(3)}>0,(\bar{\nu}_2)^{(3)}<0$ and respectively $(\bar{u}_1)^{(3)}>0,(\bar{u}_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_2)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_2)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$	320
Definition of $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$ by $(m_2)^{(3)}=(\nu_0)^{(3)},(m_1)^{(3)}=(\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)}<(\nu_1)^{(3)}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\bar{\nu}_1)^{(3)},\boldsymbol{if}\ (\nu_1)^{(3)}<(\nu_0)^{(3)}<(\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)}=\frac{G_{20}^{0}}{G_{21}^{0}}}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)}<(\nu_0)^{(3)}$	321

and analogously 322

$(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}$

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$

Then the solution of global equations satisfies the inequalities

$G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$

$(p_i)^{(3)}$ is defined by equation

$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$ 323

$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ 324

$\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$

$T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$ 325

$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$ 326

$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ 327

$\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- 328

Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$

$(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$

$(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$

$(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$

Behavior of the solutions of equation

Theorem: If we denote and define

Definition of $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$:

$(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying

$-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)}, \; \boldsymbol{if} \; (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}, \boldsymbol{if} \; (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)}, \; \boldsymbol{if} \; (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)}, \; \boldsymbol{if} \; (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}, \boldsymbol{if} \; (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if} \; (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)})}\left[e^{((S_1)^{(4)} - (p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\big((G_{31}), t\big) - (b_{29}'')^{(5)}\big((G_{31}), t\big) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0, (\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0, (u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,	340

and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}, \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}((G_{35}), t) - (b''_{33})^{(6)}((G_{35}), t) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)}, , (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \; \boldsymbol{if} \; (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \; (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \; \boldsymbol{if} \; (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if} \; (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \; (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)} t}$ where $(p_i)^{(6)}$ is defined by equation	353

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}\left((G_{39}), t\right) - (b_{37}'')^{(7)}\left((G_{39}), t\right) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the	362

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2+(\sigma_2)^{(7)}\nu^{(7)}-(a_{36})^{(7)}=0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2+(\tau_2)^{(7)}u^{(7)}-(b_{36})^{(7)}=0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)}=(\nu_0)^{(7)}, (m_1)^{(7)}=(\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)}<(\nu_1)^{(7)}$ $(m_2)^{(7)}=(\nu_1)^{(7)}, (m_1)^{(7)}=(\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)}<(\nu_0)^{(7)}<(\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)}=(\nu_1)^{(7)}, (m_1)^{(7)}=(\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)}<(\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)}=(u_0)^{(7)}, (\mu_1)^{(7)}=(u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)}<(u_1)^{(7)}$ $(\mu_2)^{(7)}=(u_1)^{(7)}, (\mu_1)^{(7)}=(\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)}<(u_0)^{(7)}<(\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)}=\frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)}=(u_1)^{(7)}, (\mu_1)^{(7)}=(u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)}<(u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t}-e^{-(S_2)^{(7)}t}\right]+G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t}-e^{-(a_{38}')^{(7)}t}\right]+G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t}-e^{-(b_{38}')^{(7)}t}\right]+T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^0 e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)},(S_2)^{(7)},(R_1)^{(7)},(R_2)^{(7)}$:- Where $(S_1)^{(7)}=(a_{36})^{(7)}(m_2)^{(7)}-(a_{36}^{'})^{(7)}$ $(S_2)^{(7)}=(a_{38})^{(7)}-(p_{38})^{(7)}$ $(R_1)^{(7)}=(b_{36})^{(7)}(\mu_2)^{(7)}-(b_{36}^{'})^{(7)}$ $(R_2)^{(7)}=(b_{38}^{'})^{(7)}-(r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)},(\sigma_2)^{(8)},(\tau_1)^{(8)},(\tau_2)^{(8)}$: $(\sigma_1)^{(8)},(\sigma_2)^{(8)},(\tau_1)^{(8)},(\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)}\leq-(a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}-(a_{40}^{''})^{(8)}(T_{41},t)+(a_{41}^{''})^{(8)}(T_{41},t)\leq-(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)}\leq-(b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(b_{40}^{''})^{(8)}\big((G_{43}),t\big)-(b_{41}^{''})^{(8)}\big((G_{43}),t\big)\leq-(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)},(\nu_2)^{(8)},(u_1)^{(8)},(u_2)^{(8)},\nu^{(8)},u^{(8)}$: By $(\nu_1)^{(8)}>0,(\nu_2)^{(8)}<0$ and respectively $(u_1)^{(8)}>0,(u_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2+(\sigma_1)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\big(u^{(8)}\big)^2+(\tau_1)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ and	372
Definition of $(\bar{\nu}_1)^{(8)},,(\bar{\nu}_2)^{(8)},(\bar{u}_1)^{(8)},(\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)}>0,(\bar{\nu}_2)^{(8)}<0$ and respectively $(\bar{u}_1)^{(8)}>0,(\bar{u}_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2+(\sigma_2)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\big(u^{(8)}\big)^2+(\tau_2)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ **Definition of** $(m_1)^{(8)},(m_2)^{(8)},(\mu_1)^{(8)},(\mu_2)^{(8)},(\nu_0)^{(8)}$:- If we define $(m_1)^{(8)},(m_2)^{(8)},(\mu_1)^{(8)},(\mu_2)^{(8)}$ by $(m_2)^{(8)}=(\nu_0)^{(8)},(m_1)^{(8)}=(\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)}<(\nu_1)^{(8)}$	

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)} t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)} t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)})} \left[e^{((S_1)^{(8)} - (p_{40})^{(8)})t} - e^{-(S_2)^{(8)} t} \right] + G_{42}^0 e^{-(S_2)^{(8)} t} \leq G_{42}(t) \leq \right.$ $\left. \frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)} - (a'_{42})^{(8)})} [e^{(S_1)^{(8)} t} - e^{-(a'_{42})^{(8)} t}] + G_{42}^0 e^{-(a'_{42})^{(8)} t} \right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)} - (b'_{42})^{(8)})} \left[e^{(R_1)^{(8)} t} - e^{-(b'_{42})^{(8)} t} \right] + T_{42}^0 e^{-(b'_{42})^{(8)} t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)} + (r_{40})^{(8)} + (R_2)^{(8)})} \left[e^{((R_1)^{(8)} + (r_{40})^{(8)})t} - e^{-(R_2)^{(8)} t} \right] + T_{42}^0 e^{-(R_2)^{(8)} t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)} (m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$

$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \le -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \le -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \le -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \le -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)}, , (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},\ \boldsymbol{if}\ (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)},\ \boldsymbol{if}\ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,
and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)},\ \boldsymbol{if}\ (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)},\ \boldsymbol{if}\ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,
and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if}\ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	
$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$ $\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t})$	
$T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$ $\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$ $(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$	
Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\nu^{(1)} = \frac{G_{13}}{G_{14}}$ It follows $-\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-	383

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}$, *then* $(\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}$, *then* $(\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
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From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}$, $\boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390
In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$	391
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If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
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Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$$

<u>Definition of</u> $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

<u>Definition of</u> $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
Proof : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **Definition of** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	405
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right) - (a_{33}'')^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\le\frac{d\nu^{(6)}}{dt}\le-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\ge\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\le\nu^{(6)}(t)\le(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\le\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\le\nu^{(6)}(t)\le(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\le\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\le\nu^{(6)}(t)\le$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\le(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\le(\bar{\nu}_1)^{(6)}\le\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\le\nu^{(6)}(t)\le\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\le(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\le\nu^{(6)}(t)\le(m_1)^{(6)}$, $\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\le u^{(6)}(t)\le(\mu_1)^{(6)}$, $\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**
Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$**, and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420
Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$	421

From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	424

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$**, and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \le \frac{d\nu^{(9)}}{dt} \le -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \ge \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \le \nu^{(9)}(t) \le (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \le \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \le \nu^{(9)}(t) \le (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \le \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \le \nu^{(9)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \le (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$,

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$

with $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system

Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations 426

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$ 427

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$ 428

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$, 429

$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

$with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\,]T_{14} \,=\, 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\,]T_{15} \,=\, 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} \,=\, 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} \,=\, 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} \,=\, 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\,]T_{16} \,=\, 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\,]T_{17} \,=\, 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\,]T_{18} \,=\, 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} \,=\, 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} \,=\, 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} \,=\, 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\,]T_{20} \,=\, 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\,]T_{21} \,=\, 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\,]T_{22} \,=\, 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} \,=\, 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25})\right]G_{25} \,=\, 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25})\right]G_{26} \,=\, 0$	457
$(b_{24})^{(4)}T_{25} - [(b'_{24})^{(4)} - (b''_{24})^{(4)}\big((G_{27})\big)\,]T_{24} \,=\, 0$	458
$(b_{25})^{(4)}T_{24} - [(b'_{25})^{(4)} - (b''_{25})^{(4)}\big((G_{27})\big)\,]T_{25} \,=\, 0$	459
$(b_{26})^{(4)}T_{25} - [(b'_{26})^{(4)} - (b''_{26})^{(4)}\big((G_{27})\big)\,]T_{26} \,=\, 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (h) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) + (a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
<u>Definition and uniqueness of</u> T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
<u>Definition and uniqueness of</u> T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
<u>Definition and uniqueness of</u> T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
<u>Definition and uniqueness of</u> T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	499
<u>Definition and uniqueness of</u> T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*})=0$. With this value , we obtain from the three first equations $G_{40}=\frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42}=\frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*})=0$. With this value , we obtain from the three first equations $G_{44}=\frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46}=\frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G)=(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)}-(b_{13})^{(1)}(b_{14})^{(1)}-$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G)+(b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right]+(b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G)=0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*})=0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19})=(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19})+(b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right]+(b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19})=0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	504
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By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{25} such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{29} such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{33} such that $\varphi({G_{35}}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{37} such that $\varphi({G_{39}}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi({G_{43}}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^{*} given by $\varphi((G_{31})^{*})=0$, T_{29}^{*} given by $f(T_{29}^{*})=0$ and $G_{28}^{*}=\frac{(a_{28})^{(5)}G_{29}^{*}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*}=\frac{(a_{30})^{(5)}G_{29}^{*}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	
$T_{28}^{*}=\frac{(b_{28})^{(5)}T_{29}^{*}}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*}=\frac{(b_{30})^{(5)}T_{29}^{*}}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*})=0$, T_{33}^{*} given by $f(T_{33}^{*})=0$ and $G_{32}^{*}=\frac{(a_{32})^{(6)}G_{33}^{*}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*}=\frac{(a_{34})^{(6)}G_{33}^{*}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*}=\frac{(b_{32})^{(6)}T_{33}^{*}}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^{*})]}$, $T_{34}^{*}=\frac{(b_{34})^{(6)}T_{33}^{*}}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*})=0$, T_{37}^{*} given by $f(T_{37}^{*})=0$ and $G_{36}^{*}=\frac{(a_{36})^{(7)}G_{37}^{*}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}^{*}=\frac{(a_{38})^{(7)}G_{37}^{*}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$ $T_{36}^{*}=\frac{(b_{36})^{(7)}T_{37}^{*}}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^{*})]}$, $T_{38}^{*}=\frac{(b_{38})^{(7)}T_{37}^{*}}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*})=0$, T_{41}^{*} given by $f(T_{41}^{*})=0$ and $G_{40}^{*}=\frac{(a_{40})^{(8)}G_{41}^{*}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42}^{*}=\frac{(a_{42})^{(8)}G_{41}^{*}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$ $T_{40}^{*}=\frac{(b_{40})^{(8)}T_{41}^{*}}{[(b_{40}^{'})^{(8)}-(b_{40}^{''})^{(8)}((G_{43})^{*})]}$, $T_{42}^{*}=\frac{(b_{42})^{(8)}T_{41}^{*}}{[(b_{42}^{'})^{(8)}-(b_{42}^{''})^{(8)}((G_{43})^{*})]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^{*} given by $\varphi((G_{47})^{*})=0$, T_{45}^{*} given by $f(T_{45}^{*})=0$ and $G_{44}^{*}=\frac{(a_{44})^{(9)}G_{45}^{*}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46}^{*}=\frac{(a_{46})^{(9)}G_{45}^{*}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)}T_{45}^*}{[(b_{44}')^{(9)}-(b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)}T_{45}^*}{[(b_{46}')^{(9)}-(b_{46}'')^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)}G_{13}^*\mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)}G_{14}^*\mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)}G_{15}^*\mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)}T_{13}^*\mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)}T_{14}^*\mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)}T_{15}^*\mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_{j}\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_{j}\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_{j}\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}\left((G_{23})^{*}\right) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_{j}\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_{j}\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_{j}\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)} G_{24}^* \mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)} G_{25}^* \mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)} G_{26}^* \mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)} T_{24}^* \mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)} T_{25}^* \mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)} T_{26}^* \mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b''_i)^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)} G_{28}^* \mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)} G_{29}^* \mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)} G_{30}^* \mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)} T_{28}^* \mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)} T_{29}^* \mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)} T_{30}^* \mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \;,\; \frac{\partial (b_i'')^{(6)}}{\partial G_j}((G_{35})^*) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \;,\; \frac{\partial (b_i'')^{(7)}}{\partial G_j}((G_{39})^{**}) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G^*_{38}\,\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T^*_{36}\,\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T^*_{37}\,\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T^*_{38}\,\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}}(T^*_{41}) = (q_{41})^{(8)} \quad , \frac{\partial (b''_i)^{(8)}}{\partial G_j}(\,(G_{43})^*\,) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G^*_{40}\,\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G^*_{41}\,\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G^*_{42}\,\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T^*_{40}\,\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T^*_{41}\,\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T^*_{42}\,\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(9)}$ *and* $(b''_i)^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{45})^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b''_i)^{(9)}}{\partial G_j}((G_{47})^*) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a'_{44})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^*\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a'_{45})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^*\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a'_{46})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^*\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b'_{44})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^*\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b'_{45})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^*\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b'_{46})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^*\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b'_{15})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a'_{15})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a'_{14})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^* + (b_{14})^{(1)}s_{(13),(13)}T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b'_{13})^{(1)} + (b'_{14})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$ $+\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$ +	

$\left((\lambda)^{(2)}+(b_{18}')^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}')^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}')^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}')^{(2)}+(b_{17}')^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(3)}+(b_{22}')^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}')^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$

$+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$

$+$

$((\lambda)^{(4)}+(b'_{26})^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a'_{26})^{(4)}+(p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)}+(a'_{24})^{(4)}+(p_{24})^{(4)})(q_{25})^{(4)}G^*_{25}+(a_{25})^{(4)}(q_{24})^{(4)}G^*_{24}\right)\right]$ $\left(((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)})s_{(25),(25)}T^*_{25}+(b_{25})^{(4)}s_{(24),(25)}T^*_{25}\right)$ $+\left(((\lambda)^{(4)}+(a'_{25})^{(4)}+(p_{25})^{(4)})(q_{24})^{(4)}G^*_{24}+(a_{24})^{(4)}(q_{25})^{(4)}G^*_{25}\right)$ $\left(((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)})s_{(25),(24)}T^*_{25}+(b_{25})^{(4)}s_{(24),(24)}T^*_{24}\right)$ $\left(((\lambda)^{(4)})^2+((a'_{24})^{(4)}+(a'_{25})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^2+((b'_{24})^{(4)}+(b'_{25})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)})(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^2+((a'_{24})^{(4)}+(a'_{25})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a'_{24})^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G^*_{25}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G^*_{24}\right)$ $\left(((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)})s_{(25),(26)}T^*_{25}+(b_{25})^{(4)}s_{(24),(26)}T^*_{24}\right)\}=0$ +	
$((\lambda)^{(5)}+(b'_{30})^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a'_{30})^{(5)}+(p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)}+(a'_{28})^{(5)}+(p_{28})^{(5)})(q_{29})^{(5)}G^*_{29}+(a_{29})^{(5)}(q_{28})^{(5)}G^*_{28}\right)\right]$ $\left(((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)})s_{(29),(29)}T^*_{29}+(b_{29})^{(5)}s_{(28),(29)}T^*_{29}\right)$ $+\left(((\lambda)^{(5)}+(a'_{29})^{(5)}+(p_{29})^{(5)})(q_{28})^{(5)}G^*_{28}+(a_{28})^{(5)}(q_{29})^{(5)}G^*_{29}\right)$ $\left(((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)})s_{(29),(28)}T^*_{29}+(b_{29})^{(5)}s_{(28),(28)}T^*_{28}\right)$ $\left(((\lambda)^{(5)})^2+((a'_{28})^{(5)}+(a'_{29})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^2+((b'_{28})^{(5)}+(b'_{29})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)})(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^2+((a'_{28})^{(5)}+(a'_{29})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)}+(a'_{28})^{(5)}+(p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G^*_{29}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G^*_{28}\right)$ $\left(((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)})s_{(29),(30)}T^*_{29}+(b_{29})^{(5)}s_{(28),(30)}T^*_{28}\right)\}=0$ +	

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

+

$((\lambda)^{(8)}+(b_{42}')^{(8)}-(r_{42})^{(8)})\{((\lambda)^{(8)}+(a_{42}')^{(8)}+(p_{42})^{(8)})$

$\left[\left(((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)})(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)})s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(((\lambda)^{(8)}+(a_{41}')^{(8)}+(p_{41})^{(8)})(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)})s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(((\lambda)^{(8)})^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$\left(((\lambda)^{(8)})^{2}+\left((b_{40}')^{(8)}+(b_{41}')^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$+\left(((\lambda)^{(8)})^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)})s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$

+

$((\lambda)^{(9)}+(b_{46}')^{(9)}-(r_{46})^{(9)})\{((\lambda)^{(9)}+(a_{46}')^{(9)}+(p_{46})^{(9)})$

$\left[\left(((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)})(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$\left(((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)})s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(((\lambda)^{(9)}+(a_{45}')^{(9)}+(p_{45})^{(9)})(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)})s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(((\lambda)^{(9)})^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$\left(((\lambda)^{(9)})^{2}+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$+\left(((\lambda)^{(9)})^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)})s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.	

SECTION NINE

Holographic Spectral Functions And Diffusion Constants For Fundamental Matter

INTRODUCTION—VARIABLES USED

Holographic spectral functions and diffusion constants for fundamental matter; Robert C. Myers, Andrei O. Starinets, Rowan M. Thomson

(1) The holographic dual of large-Nc super-Yang-Mills coupled to (e&eb) a small number of flavours of fundamental matter, Nf << Nc, is described by (e) Nf probe D7-branes in (eb) the gravitational background of Nc black D3-branes.

(2) This system undergoes a first order phase transition characterised by (e&eb) the `melting' of (e) the mesons.

(3) Authors study the high temperature phase in which the D7-branes extend through (e&eb) the black hole horizon.

(4) In this phase, authors compute the spectral function for vector, scalar and pseudoscalar modes on (e&eb) the D7-brane probe.

(5) They also compute the diffusion constant for (e) the flavour currents. Subjects: High Energy Physics - Theory (hep-th) Journal reference: JHEP 0711:091,2007 DOI: 10.1088/1126-6708/2007/11/091 Cite as: arXiv:0706.0162 [hep-th] (or arXiv:0706.0162v3 [hep-th] for this version)

NOTATION

Module One

The holographic dual of large-Nc super-Yang-Mills coupled to (e&eb) a small number of flavours of fundamental matter, Nf << Nc, is described by (e) Nf probe D7-branes in (eb) the gravitational background of Nc black D3-branes

G_{13} : Category one of **holographic dual of large-Nc super-Yang-Mills;** small number of flavours of fundamental matter, Nf << Nc, is described by (e) Nf probe D7-branes in (eb) the gravitational background of Nc black D3-branes

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of small number of flavours of fundamental matter, Nf << Nc, is described by (e) Nf probe D7-branes in (eb) the gravitational background of Nc black D3-branes **;holographic dual of large-Nc**

super-Yang-Mills

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

The holographic dual of large-Nc super-Yang-Mills coupled to a small number of flavours of fundamental matter, Nf << Nc, is described by (e) Nf probe D7-branes in (eb) the gravitational background of Nc black D3-branes

G_{16} : Category one of Nf probe D7-branes in (eb) the gravitational background of Nc black D3-branes

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of holographic dual of large-Nc super-Yang-Mills coupled to a small number of flavours of fundamental matter, Nf << Nc

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

The holographic dual of large-Nc super-Yang-Mills coupled to a small number of flavours of fundamental matter, Nf << Nc, is described by Nf probe D7-branes in (eb) the **gravitational background of Nc black D3-branes**

G_{20} : Category one of holographic dual of large-Nc super-Yang-Mills coupled to a small number of flavours of fundamental matter, Nf << Nc, is described by Nf probe D7-branes; **gravitational background of Nc black D3-branes**

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of **gravitational background of Nc black D3-branes** ;holographic dual of large-Nc super-Yang-Mills coupled to a small number of flavours of fundamental matter, Nf << Nc, is described by Nf probe D7-branes

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

This system undergoes a first order phase transition characterised by (e&eb) the `melting' of the mesons

G_{24} : Category one of **system undergoes a first order phase transition characterised;** melting' of the mesons

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of melting' of the mesons **;system undergoes a first order phase transition characterised**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

Authors study the high temperature phase in which the D7-branes extend through (e&eb) the black hole horizon

G_{28} : Category one of **high temperature phase in which the D7-branes ;** black hole horizon

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of black hole horizon; **high temperature phase in which the D7-branes**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

In this phase, authors compute the spectral function for vector, scalar and pseudoscalar modes on (e&eb) the D7-brane probe

G_{32} : Category one of **spectral function for vector, scalar and pseudoscalar modes;** D7-brane probe

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of D7-brane probe; **spectral function for vector, scalar and pseudoscalar modes**

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

Holographic Spectral Functions at Finite Baryon Density Javier Mas, Jonathan P. Shock, Javier Tarrio, Dimitrios Zoakos

(1) Using the AdS/CFT correspondence, authors compute the spectral functions of thermal super Yang Mills at large N_c coupled to (e&eb) a small number of flavours of fundamental matter, N_f<<N_c, in (eb) the presence of (e) a nonzero baryon density.
(2) The holographic dual of such a theory involves (e&eb) the addition of probe D7-branes with (e&eb) a background worldvolume gauge field switched on, embedded in (eb) the geometry of (e) a stack of black D3-branes.
(3) Authors perform the analysis in the vector and scalar channels which become coupled for (e)

nonzero values of the spatial momentum and (e&eb) baryon density.

(4) In addition, authors obtain the effect of the presence of net baryon charge on (e&eb) the photon production.

(5) They also extract the conductivity and find perfect agreement with (=) the results derived by Karch and O'Bannon in a macroscopic setup. Subjects: High Energy Physics - Theory (hep-th) Journal reference: JHEP 0809:009,2008 DOI: 10.1088/1126-6708/2008/09/009 Cite as: arXiv:0805.2601 [hep-th] (or arXiv:0805.2601v2 [hep-th] for this version)

Using the AdS/CFT correspondence, authors compute the spectral functions of thermal super Yang Mills at large N_c coupled to (e&eb) a small number of flavours of fundamental matter, N_f<<N_c, in (eb) the presence of (e) a nonzero baryon density

G_{36} : Category one of **AdS/CFT correspondence, authors compute the spectral functions of thermal super Yang Mills at large N_c;** small number of flavours of fundamental matter, N_f<<N_c, in the presence of (e) a nonzero baryon density

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of small number of flavours of fundamental matter, N_f<<N_c, in (eb) the presence of (e) a nonzero baryon density **;AdS/CFT correspondence, authors compute the spectral functions of thermal super Yang Mills at large N_c**

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

The holographic dual of such a theory involves (e&eb) the addition of probe D7-branes with (e&eb) a background worldvolume gauge field switched on, embedded in (eb) the geometry of (e) a stack of black D3-branes

G_{40} : Category one of **holographic dual of such a theory;** addition of probe D7-branes with (e&eb) a background worldvolume gauge field switched on, embedded in (eb) the geometry of (e) a stack of black D3-branes

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of addition of probe D7-branes with (e&eb) a background worldvolume gauge field switched on, embedded in (eb) the geometry of (e) a stack of black D3-branes **;holographic dual of such a theory**

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

The holographic dual of such a theory involves the addition of probe D7-branes with a background worldvolume gauge field switched on, embedded in (eb) the geometry of (e) a stack of black D3-branes

G_{44} : Category one of **holographic dual of such a theory involves the addition of probe D7-branes;** background worldvolume gauge field switched on, embedded in (eb) the geometry of (e) a stack of black D3-branes

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of background worldvolume gauge field switched on, embedded in (eb) the geometry of (e) a stack of black D3-branes; **holographic dual of such a theory involves the addition of probe D7-branes**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)} (T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)} (G, t) \right] T_{13}$	4

$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b_{14}')^{(1)} - (b_{14}'')^{(1)}(G,t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G,t) \right] T_{15}$	6
$+(a_{13}'')^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}'')^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17},t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17},t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17},t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b_{16}')^{(2)} - (b_{16}'')^{(2)}\left((G_{19}),t\right) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b_{17}')^{(2)} - (b_{17}'')^{(2)}\left((G_{19}),t\right) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b_{18}')^{(2)} - (b_{18}'')^{(2)}\left((G_{19}),t\right) \right] T_{18}$	12
$+(a_{16}'')^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}'')^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t) \right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21},t) \right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21},t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23},t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23},t) \right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23},t) \right] T_{22}$	18
$+(a_{20}'')^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}'')^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25},t) \right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25},t) \right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25},t) \right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)}\left((G_{27}),t\right) \right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)}\left((G_{27}),t\right) \right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b_{26}')^{(4)} - (b_{26}'')^{(4)}\left((G_{27}),t\right) \right] T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}'')^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	

Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right] T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33},t)\right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33},t)\right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33},t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}),t\right)\right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right] T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t)\right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t)\right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t)\right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}),t\right)\right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}),t\right)\right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}),t\right)\right] T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41},t)\right] G_{42}$	*45*

$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}), t\right)\right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}), t\right)\right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}), t\right)\right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}, t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}, t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}), t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}), t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}), t\right)\right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}), t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14}, t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{40})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14}, t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{41})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14}, t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{42})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14}, t)}$, $\boxed{(a''_{14})^{(1)}(T_{14}, t)}$, $\boxed{(a''_{15})^{(1)}(T_{14}, t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17}, t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21}, t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21}, t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21}, t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25}, t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25}, t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25}, t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29}, t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29}, t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29}, t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33}, t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33}, t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33}, t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37}, t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37}, t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37}, t)}$ are seventh augmentation coefficient for 1,2,3	

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16}$	*61*

$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[\begin{matrix}(a_{17}^{'})^{(2)}\boxed{+(a_{17}^{''})^{(2)}(T_{17},t)}\boxed{+(a_{14}^{''})^{(1,1,)}(T_{14},t)}\boxed{+(a_{21}^{''})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{29}^{''})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{33}^{''})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{37}^{''})^{(7,7,7)}(T_{37},t)}\boxed{+(a_{41}^{''})^{(8,8,8)}(T_{41},t)}\boxed{+(a_{45}^{''})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{17}$	*62*
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[\begin{matrix}(a_{18}^{'})^{(2)}\boxed{+(a_{18}^{''})^{(2)}(T_{17},t)}\boxed{+(a_{15}^{''})^{(1,1,)}(T_{14},t)}\boxed{+(a_{22}^{''})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{30}^{''})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{34}^{''})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{38}^{''})^{(7,7,7)}(T_{37},t)}\boxed{+(a_{42}^{''})^{(8,8,8)}(T_{41},t)}\boxed{+(a_{46}^{''})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{18}$	*63*
Where $\boxed{+(a_{16}^{''})^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{13}^{''})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}^{''})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}^{''})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}^{''})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{36}^{''})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}^{''})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}^{''})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{40}^{''})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{44}^{''})^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[\begin{matrix}(b_{16}^{'})^{(2)}\boxed{-(b_{16}^{''})^{(2)}(G_{19},t)}\boxed{-(b_{13}^{''})^{(1,1,)}(G,t)}\boxed{-(b_{20}^{''})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b_{28}^{''})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b_{32}^{''})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b_{36}^{''})^{(7,7,7)}(G_{39},t)}\boxed{-(b_{40}^{''})^{(8,8,8)}(G_{43},t)}\boxed{-(b_{44}^{''})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{16}$	*64*
$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[\begin{matrix}(b_{17}^{'})^{(2)}\boxed{-(b_{17}^{''})^{(2)}(G_{19},t)}\boxed{-(b_{14}^{''})^{(1,1,)}(G,t)}\boxed{-(b_{21}^{''})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b_{29}^{''})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b_{33}^{''})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b_{37}^{''})^{(7,7,7)}(G_{39},t)}\boxed{-(b_{41}^{''})^{(8,8,8)}(G_{43},t)}\boxed{-(b_{45}^{''})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{17}$	*65*
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[\begin{matrix}(b_{18}^{'})^{(2)}\boxed{-(b_{18}^{''})^{(2)}(G_{19},t)}\boxed{-(b_{15}^{''})^{(1,1,)}(G,t)}\boxed{-(b_{22}^{''})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b_{30}^{''})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b_{34}^{''})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b_{38}^{''})^{(7,7,7)}(G_{39},t)}\boxed{-(b_{42}^{''})^{(8,8,8)}(G_{43},t)}\boxed{-(b_{46}^{''})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{18}$	*66*
where $\boxed{-(b_{16}^{''})^{(2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{13}^{''})^{(1,1,)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1,1,)}(G,t)}$ are second detrition coefficients for category	

1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{20}$$ 67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21}$$ 68

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22}$$ 69

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation

coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)}\boxed{-(b''_{20})^{(3)}(G_{23},t)}\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)}\boxed{-(b''_{21})^{(3)}(G_{23},t)}\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)}\boxed{-(b''_{22})^{(3)}(G_{23},t)}\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[\begin{matrix} (a'_{24})^{(4)}\boxed{+(a''_{24})^{(4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$
are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$
are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$
are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$
are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$
are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients*

for category 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{28}$	*79*
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{29}$	*80*
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{30}$	*81*
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation	

coefficients for category 1,2, 3 $+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)$ are eighth augmentation coefficients for category 1,2, 3 $+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\begin{bmatrix}(b'_{28})^{(5)}-(b''_{28})^{(5)}(G_{31},t) & -(b''_{24})^{(4,4,)}(G_{27},t) & -(b''_{32})^{(6,6,6)}(G_{35},t)\\ -(b''_{13})^{(1,1,1,1,1)}(G,t) & -(b''_{16})^{(2,2,2,2,2)}(G_{19},t) & -(b''_{20})^{(3,3,3,3,3)}(G_{23},t)\\ -(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t) & -(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t) & -(b''_{44})^{(9,9,9,9,9)}(G_{47},t)\end{bmatrix}T_{28}$	82
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\begin{bmatrix}(b'_{29})^{(5)}-(b''_{29})^{(5)}(G_{31},t) & -(b''_{25})^{(4,4,)}(G_{27},t) & -(b''_{33})^{(6,6,6)}(G_{35},t)\\ -(b''_{14})^{(1,1,1,1,1)}(G,t) & -(b''_{17})^{(2,2,2,2,2)}(G_{19},t) & -(b''_{21})^{(3,3,3,3,3)}(G_{23},t)\\ -(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t) & -(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t) & -(b''_{45})^{(9,9,9,9,9)}(G_{47},t)\end{bmatrix}T_{29}$	83
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\begin{bmatrix}(b'_{30})^{(5)}-(b''_{30})^{(5)}(G_{31},t) & -(b''_{26})^{(4,4,)}(G_{27},t) & -(b''_{34})^{(6,6,6)}(G_{35},t)\\ -(b''_{15})^{(1,1,1,1,1,)}(G,t) & -(b''_{18})^{(2,2,2,2,2)}(G_{19},t) & -(b''_{22})^{(3,3,3,3,3)}(G_{23},t)\\ -(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t) & -(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t) & -(b''_{46})^{(9,9,9,9,9)}(G_{47},t)\end{bmatrix}T_{30}$	84
where $-(b''_{28})^{(5)}(G_{31},t)$, $-(b''_{29})^{(5)}(G_{31},t)$, $-(b''_{30})^{(5)}(G_{31},t)$ *are first detrition coefficients for category* 1, 2 *and* 3 $-(b''_{24})^{(4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,)}(G_{27},t)$ *are second detrition coefficients for category* 1,2 *and* 3 $-(b''_{32})^{(6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6)}(G_{35},t)$ *are third detrition coefficients for category* 1,2 *and* 3 $-(b''_{13})^{(1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1)}(G,t)$, $-(b''_{15})^{(1,1,1,1,1,)}(G,t)$ are fourth detrition coefficients for category 1,2, and 3 $-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)$ are fifth detrition coefficients for category 1,2, and 3 $-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1,2, and 3 $-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2, and 3 $-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1,2, and 3 $-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}$ $-\begin{bmatrix}(a'_{32})^{(6)}+(a''_{32})^{(6)}(T_{33},t) & +(a''_{28})^{(5,5,5)}(T_{29},t) & +(a''_{24})^{(4,4,4,)}(T_{25},t)\\ +(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t) & +(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t) & +(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)\\ +(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t) & +(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t) & +(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)\end{bmatrix}G_{32}$	85

$$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\begin{bmatrix}(a'_{33})^{(6)}\boxed{+(a''_{33})^{(6)}(T_{33},t)}\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{33}$$	86
$$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\begin{bmatrix}(a'_{34})^{(6)}\boxed{+(a''_{34})^{(6)}(T_{33},t)}\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{34}$$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\begin{bmatrix}(b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{32}$$	88
$$\frac{dT_{33}}{dt}=(b_{33})^{(6)}T_{32}-\begin{bmatrix}(b'_{33})^{(6)}\boxed{-(b''_{33})^{(6)}(G_{35},t)}\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{33}$$	89
$$\frac{dT_{34}}{dt}=(b_{34})^{(6)}T_{33}-\begin{bmatrix}(b'_{34})^{(6)}\boxed{-(b''_{34})^{(6)}(G_{35},t)}\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{34}$$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3	

$-(b''_{28})^{(5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5)}(G_{31},t)$ *are second detrition coefficients for category* 1, 2 *and* 3

$-(b''_{24})^{(4,4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,)}(G_{27},t)$ *are third detrition coefficients for category* 1,2 *and* 3

$-(b''_{13})^{(1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1)}(G,t)$, $-(b''_{15})^{(1,1,1,1,1,1)}(G,t)$ are fourth detrition coefficients for category 1, 2, and 3

$-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)$ are fifth detrition coefficients for category 1, 2, and 3

$-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1, 2, and 3

$-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2, and 3

$-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2, and 3

$-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 91$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14} \quad 92$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \quad 93$$

Where $(a''_{36})^{(7)}(T_{37},t)$, $(a''_{37})^{(7)}(T_{37},t)$, $(a''_{38})^{(7)}(T_{37},t)$ are first augmentation coefficients for category 1, 2 and 3

$+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3

$+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$	

are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*95*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3	

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13}$	96
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} =$ $(b_{44})^{(9)} T_{45} -$	

$$\left[\begin{matrix} (b_{44}^{'})^{(9)}\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$$(b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b_{45}^{'})^{(9)}\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$$(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}^{'})^{(9)}\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3

Where we suppose

$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i, j = 13,14,15$ 97

The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(1)}, \ (r_i)^{(1)}$:

$(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	

$(a_i^{''})^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i^{'})^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty} (a_i^{''})^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty} (b_i^{''})^{(2)}\left((G_{19}),t\right) = (r_i)^{(2)}$	105
<u>Definition of</u> $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(2)}(T_{17}^{'},t) - (a_i^{''})^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}^{'}\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i^{''})^{(2)}((G_{19})',t) - (b_i^{''})^{(2)}\left((G_{19}),t\right)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19}) - (G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'},t)$ and $(a_i^{''})^{(2)}(T_{17},t)$. $(T_{17}^{'},t)$ and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i^{''})^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} \ , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
<u>Definition of</u> $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i^{'})^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i^{'})^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$	112

The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (r_i)^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	
$lim_{T_2 \to \infty}(a_i^{''})^{(3)}(T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty}(b_i^{''})^{(3)}(G_{23}, t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20,21,22}$	113
They satisfy Lipschitz condition: $\|(a_i^{''})^{(3)}(T_{21}^{'}, t) - (a_i^{''})^{(3)}(T_{21}, t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}^{'}\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i^{''})^{(3)}(G_{23}{'}, t) - (b_i^{''})^{(3)}(G_{23}, t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}{'}\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and$(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} \ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and \ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[\ (a_i)^{(3)} + (a_i^{'})^{(3)} + \ (\hat{A}_{20})^{(3)} + \ (\hat{P}_{20})^{(3)} \ (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[\ (b_i)^{(3)} + (b_i^{'})^{(3)} + \ (\hat{B}_{20})^{(3)} + \ (\hat{Q}_{20})^{(3)} \ (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i, j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded.	117

Definition of $(p_i)^{(4)}, \ (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}),t) \leq \ (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i^{''})^{(4)}((G_{27}),t) = \ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, \ (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} \ , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and \ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)}, \ (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (a_i)^{(4)} + (a_i^{'})^{(4)} + \ (\hat{A}_{24})^{(4)} + \ (\hat{P}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)} + (b_i^{'})^{(4)} + \ (\hat{B}_{24})^{(4)} + \ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded.	122

Definition of $(p_i)^{(5)}, \ (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}),t) \leq \ (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t) = \ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(5)}(T_{29}^{'},t) - (a_i^{''})^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}^{'}\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i^{''})^{(5)}((G_{31})^{'},t) - (b_i^{''})^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})^{'}\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and $(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}} \ , \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and \ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i^{'})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)} + (a_i^{'})^{(5)} + \ (\hat{A}_{28})^{(5)} + \ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)} + (b_i^{'})^{(5)} + \ (\hat{B}_{28})^{(5)} + \ (\hat{Q}_{28})^{(5)}\ \ (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i^{'})^{(6)}, (a_i^{''})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (b_i^{''})^{(6)} > 0, \quad i,j = 32,33,34$	127

The functions $(a_i^{''})^{(6)}, (b_i^{''})^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, \ (r_i)^{(6)}$: $(a_i^{''})^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i^{''})^{(6)}((G_{35}),t) \leq \ (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(6)}(T_{33},t) = (p_i)^{(6)}$ $\lim_{G\to\infty}(b_i^{''})^{(6)}\left((G_{35}),t\right) = \ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(6)}(T_{33}^{'},t) - (a_i^{''})^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)}\lvert T_{33} - T_{33}^{'}\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i^{''})^{(6)}((G_{35})^{'},t) - (b_i^{''})^{(6)}\left((G_{35}),t\right)\rvert < (\hat{k}_{32})^{(6)}\lvert\lvert(G_{35}) - (G_{35})^{'}\rvert\lvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'},t)$ and$(a_i^{''})^{(6)}(T_{33},t)$. $(T_{33}^{'},t)$ and (T_{33},t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i^{'})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i^{'})^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)}\ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i^{'})^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)}\ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	

(WW) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (XX) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39}, t) \leq \ (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(YY) $\lim_{T_2 \to \infty} (a_i^{''})^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(ZZ)* $\lim_{G \to \infty} (b_i^{''})^{(7)} \left((G_{39}), t\right) = \ (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(7)}(T_{37}^{'}, t) - (a_i^{''})^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}^{'}\rvert e^{-(\hat{M}_{36})^{(7)} t}$ $\lvert(b_i^{''})^{(7)}((G_{39})^{'}, t) - (b_i^{''})^{(7)}\left((G_{39}), t\right)\rvert < (\hat{k}_{36})^{(7)} \lvert\lvert(G_{39}) - (G_{39})^{'}\rvert\rvert e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'}, t)$ and$(a_i^{''})^{(7)}(T_{37}, t)$. $(T_{37}^{'}, t)$ and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (AAA) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (BBB) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and \ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i^{'})^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135

$\frac{1}{(\hat{M}_{36})^{(7)}}[\ (b_i)^{(7)} + (b_i')^{(7)} + \ (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}] < 1$	
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)},\ (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \le (p_i)^{(8)} \le (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}), t) \le \ (r_i)^{(8)} \le (b_i')^{(8)} \le (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty} (a_i'')^{(8)}(T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty} (b_i'')^{(8)}\left((G_{43}), t\right) = \ (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)},\ (r_i)^{(8)}$ are positive constants and $i = 40,41,42$	
They satisfy Lipschitz condition:	
$\|(a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t)\| \le (\hat{k}_{40})^{(8)}\|T_{41} - T_{41}'\|e^{-(\hat{M}_{40})^{(8)}t}$	142
$\|(b_i'')^{(8)}((G_{43})', t) - (b_i'')^{(8)}\left((G_{43}), t\right)\| < (\hat{k}_{40})^{(8)}\|\|(G_{43}) - (G_{43})'\|\|e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}', t)$ and $(a_i'')^{(8)}(T_{41}, t)$. (T_{41}', t) and (T_{41}, t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)},\ (r_i)^{(8)}, i = 40,41,42,$	

Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i')^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t)\le(p_i)^{(9)}\le(\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t)\le (r_i)^{(9)}\le(b_i')^{(9)}\le(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t)= (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)\rvert\le(\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}'\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)\rvert<(\hat{k}_{44})^{(9)}\lVert(G_{47})-(G_{47})'\rVert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and$(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with	

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities $\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)} (\hat{k}_{44})^{(9)}] < 1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)} (\hat{k}_{44})^{(9)}] < 1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions	152

Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	

$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{16})^{(2)}, T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a'_{20})^{(3)} + a''_{20})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \le (\hat{P}_{24})^{(4)}$, $T_i^0 \le (\hat{Q}_{24})^{(4)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to$	

$\mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \le (\hat{P}_{28})^{(5)} ,T_i^0 \le (\hat{Q}_{28})^{(5)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}')^{(5)} + a_{28}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}')^{(5)} - (b_{28}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}')^{(5)} - (b_{29}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}')^{(5)} - (b_{30}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i , T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \le (\hat{P}_{32})^{(6)} ,T_i^0 \le (\hat{Q}_{32})^{(6)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	

$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{36})^{(7)}$, $T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{40})^{(8)}$, $T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}')^{(8)} + a_{40}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}')^{(8)} + (a_{41}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}')^{(8)} + (a_{42}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}')^{(8)} - (b_{40}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}')^{(8)} - (b_{41}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}')^{(8)} - (b_{42}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \le (\hat{P}_{44})^{(9)}$, $T_i^0 \le (\hat{Q}_{44})^{(9)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}')^{(9)} + a_{44}'')^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}')^{(9)} + (a_{45}'')^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}')^{(9)} + (a_{46}'')^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{46}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}')^{(9)} - (b_{44}'')^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}')^{(9)} - (b_{45}'')^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}')^{(9)} - (b_{46}'')^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{46}(s_{(44)}) \right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	

The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1\right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0\right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0}\right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}}\right)\right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1\right)$	173

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$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[((\hat{Q}_{36})^{(7)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{36})^{(7)}\right]\leq(\hat{Q}_{36})^{(7)}$	257
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The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(((G_{39})^{(1)},(T_{39})^{(1)}),((G_{39})^{(2)},(T_{39})^{(2)})\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{36})^{(7)}t}\}$ Indeed if we denote **<u>Definition of</u>** $\widetilde{(G_{39})},\widetilde{(T_{39})}:(\widetilde{(G_{39})},\widetilde{(T_{39})})=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$ It results $\lvert\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}\rvert\leq\int_0^t(a_{36})^{(7)}\lvert G_{37}^{(1)}-G_{37}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}ds_{(36)}+$ $\int_0^t\{(a'_{36})^{(7)}\lvert G_{36}^{(1)}-G_{36}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{-(\hat{M}_{36})^{(7)}s_{(36)}}+$ $(a''_{36})^{(7)}(T_{37}^{(1)},s_{(36)})\lvert G_{36}^{(1)}-G_{36}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}+$ $G_{36}^{(2)}\lvert(a''_{36})^{(7)}(T_{37}^{(1)},s_{(36)})-(a''_{36})^{(7)}(T_{37}^{(2)},s_{(36)})\rvert\ e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	258
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suffices to consider that $(a_i^{''})^{(7)}$ and $(b_i^{''})^{(7)}, i = 36,37,38$ depend only on T_{37} and respectively on $(G_{39})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 32: There does not exist any t where $G_i(t) = 0$ and $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(7)} - (a_i^{''})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\}ds_{(36)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(7)}t)} > 0$ for $t > 0$	261
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It is now sufficient to take $\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}$, $\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$ and to choose $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ large to have	266
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{Q}_{40})^{(8)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{40})^{(8)}\right] \leq (\hat{Q}_{40})^{(8)}$	268
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(((G_{43})^{(1)},(T_{43})^{(1)}),((G_{43})^{(2)},(T_{43})^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
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condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ *and* $(\hat{Q}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on $(G_{43})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 37 There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)}-(a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for t > 0	275
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
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$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(\left((G_{47})^{(1)},(T_{47})^{(1)}\right),\left((G_{47})^{(2)},(T_{47})^{(2)}\right)\right) = \sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}),(T_{47})\right)$ It results $\lvert\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{44})^{(9)}\lvert G_{45}^{(1)} - G_{45}^{(2)}\rvert e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}ds_{(44)} + \int_0^t\{(a'_{44})^{(9)}\lvert G_{44}^{(1)} - G_{44}^{(2)}\rvert e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}} + (a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)})\lvert G_{44}^{(1)} - G_{44}^{(2)}\rvert e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}} + G_{44}^{(2)}\lvert(a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a''_{44})^{(9)}(T_{45}^{(2)}, s_{(44)})\rvert\ e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$ Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$ From the hypotheses on 45,46,47,28 and 29 it follows	
$\lvert(G_{47})^{(1)} - G^{(2)}\rvert e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows	
Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by	

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(\textit{and not on } t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)}G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1/(a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2/(a_{46}^{'})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a'_{13})^{(1)} + (a'_{14})^{(1)} - (a''_{13})^{(1)}(T_{14}, t) + (a''_{14})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G, t) - (b''_{14})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)},\ if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)},\ if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t})$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
<u>**Definition of**</u> $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define	291
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$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}((G_{19}), t) - (b_{17}'')^{(2)}((G_{19}), t) \leq -(\tau_1)^{(2)}$	294
<u>**Definition of**</u> $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}(u^{(2)})^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
<u>**Definition of**</u> $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300

roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2+(\sigma_2)^{(2)}\nu^{(2)}-(a_{16})^{(2)}=0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2+(\tau_2)^{(2)}u^{(2)}-(b_{16})^{(2)}=0$	302
Definition of $(m_1)^{(2)},(m_2)^{(2)},(\mu_1)^{(2)},(\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)},(m_2)^{(2)},(\mu_1)^{(2)},(\mu_2)^{(2)}$ by	304
$(m_2)^{(2)}=(\nu_0)^{(2)},(m_1)^{(2)}=(\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)}<(\nu_1)^{(2)}$	305
$(m_2)^{(2)}=(\nu_1)^{(2)},(m_1)^{(2)}=(\bar{\nu}_1)^{(2)},\boldsymbol{if}\ (\nu_1)^{(2)}<(\nu_0)^{(2)}<(\bar{\nu}_1)^{(2)},$ and $\boxed{(\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)}=(\nu_1)^{(2)},(m_1)^{(2)}=(\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)}<(\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)}=(u_0)^{(2)},(\mu_1)^{(2)}=(u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)}<(u_1)^{(2)}$ $(\mu_2)^{(2)}=(u_1)^{(2)},(\mu_1)^{(2)}=(\bar{u}_1)^{(2)},\boldsymbol{if}\ (u_1)^{(2)}<(u_0)^{(2)}<(\bar{u}_1)^{(2)},$ and $\boxed{(u_0)^{(2)}=\frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)}=(u_1)^{(2)},(\mu_1)^{(2)}=(u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)}<(u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{\left((S_1)^{(2)}-(p_{16})^{(2)}\right)t}\leq G_{16}(t)\leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}}G_{16}^0 e^{\left((S_1)^{(2)}-(p_{16})^{(2)}\right)t}\leq G_{17}(t)\leq\frac{1}{(m_2)^{(2)}}G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}\left((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)}\right)}\left[e^{\left((S_1)^{(2)}-(p_{16})^{(2)}\right)t}-e^{-(S_2)^{(2)}t}\right]+G_{18}^0 e^{-(S_2)^{(2)}t}\leq G_{18}(t)\leq\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}\left((S_1)^{(2)}-(a_{18}')^{(2)}\right)}\left[e^{(S_1)^{(2)}t}-e^{-(a_{18}')^{(2)}t}\right]+G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t}\leq T_{16}(t)\leq T_{16}^0 e^{\left((R_1)^{(2)}+(r_{16})^{(2)}\right)t}}$	313
$\frac{1}{(\mu_1)^{(2)}}T_{16}^0 e^{(R_1)^{(2)}t}\leq T_{16}(t)\leq\frac{1}{(\mu_2)^{(2)}}T_{16}^0 e^{\left((R_1)^{(2)}+(r_{16})^{(2)}\right)t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}\left((R_1)^{(2)}-(b_{18}')^{(2)}\right)}\left[e^{(R_1)^{(2)}t}-e^{-(b_{18}')^{(2)}t}\right]+T_{18}^0 e^{-(b_{18}')^{(2)}t}\leq T_{18}(t)\leq$	315

$\frac{(a_{18})^{(2)}\mathrm{T}_{16}^{0}}{(\mu_2)^{(2)}((\mathrm{R}_1)^{(2)}+(r_{16})^{(2)}+(\mathrm{R}_2)^{(2)})}\left[\mathrm{e}^{((\mathrm{R}_1)^{(2)}+(r_{16})^{(2)})t}-\mathrm{e}^{-(\mathrm{R}_2)^{(2)}t}\right]+\mathrm{T}_{18}^{0}\mathrm{e}^{-(\mathrm{R}_2)^{(2)}t}$	
Definition of $(\mathrm{S}_1)^{(2)},(\mathrm{S}_2)^{(2)},(\mathrm{R}_1)^{(2)},(\mathrm{R}_2)^{(2)}$:-	316
Where $(\mathrm{S}_1)^{(2)}=(a_{16})^{(2)}(m_2)^{(2)}-(a_{16}^{'})^{(2)}$ $(\mathrm{S}_2)^{(2)}=(a_{18})^{(2)}-(p_{18})^{(2)}$	317
$(R_1)^{(2)}=(b_{16})^{(2)}(\mu_2)^{(1)}-(b_{16}^{'})^{(2)}$ $(\mathrm{R}_2)^{(2)}=(b_{18}^{'})^{(2)}-(r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)}\le-(a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}-(a_{20}^{''})^{(3)}(T_{21},t)+(a_{21}^{''})^{(3)}(T_{21},t)\le-(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)}\le-(b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23},t)-(b_{21}^{''})^{(3)}((G_{23}),t)\le-(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)},(\nu_2)^{(3)},(u_1)^{(3)},(u_2)^{(3)}$: By $(\nu_1)^{(3)}>0,(\nu_2)^{(3)}<0$ and respectively $(u_1)^{(3)}>0,(u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_1)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_1)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$ and By $(\bar{\nu}_1)^{(3)}>0,(\bar{\nu}_2)^{(3)}<0$ and respectively $(\bar{u}_1)^{(3)}>0,(\bar{u}_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_2)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_2)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$	320
Definition of $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$ by $(m_2)^{(3)}=(\nu_0)^{(3)},(m_1)^{(3)}=(\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)}<(\nu_1)^{(3)}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\bar{\nu}_1)^{(3)},\boldsymbol{if}\ (\nu_1)^{(3)}<(\nu_0)^{(3)}<(\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)}=\frac{G_{20}^{0}}{G_{21}^{0}}}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)}<(\nu_0)^{(3)}$	321

and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a'_{22})^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a'_{22})^{(3)}t}\right] + G_{22}^0 e^{-(a'_{22})^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b'_{22})^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b'_{22})^{(3)}t}\right] + T_{22}^0 e^{-(b'_{22})^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right) - (b_{25}^{''})^{(4)}\left((G_{27}),t\right) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ ***if*** $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, ***if*** $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ ***if*** $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ ***if*** $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, ***if*** $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)},$ ***if*** $(\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$$

$$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$$ 335

$$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$$ 336

$$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$$

Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- 337

Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$

$(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$

$(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$

$(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$

Behavior of the solutions of equation 338

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$:

$(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying

$$-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$$

$$-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\big((G_{31}), t\big) - (b_{29}'')^{(5)}\big((G_{31}), t\big) \leq -(\tau_1)^{(5)}$$

Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: 339

By $(\nu_1)^{(5)} > 0, (\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0, (u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$
and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and

Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: 340

By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$
and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$

Definition of $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:-

If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by

$(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$

$(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,

and $(v_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (v_1)^{(5)}, (m_1)^{(5)} = (v_0)^{(5)},\ \boldsymbol{if}\ (\bar{v}_1)^{(5)} < (v_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}((G_{35}), t) - (b''_{33})^{(6)}((G_{35}), t) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \ \boldsymbol{if} \ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \ \boldsymbol{if} \ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if} \ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the	362

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}^{'})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)}$ $(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} - (a_{40}^{''})^{(8)}(T_{41}, t) + (a_{41}^{''})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}), t\right) - (b_{41}^{''})^{(8)}\left((G_{43}), t\right) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
Definition of $(\bar{\nu}_1)^{(8)}, , (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)} < (\nu_1)^{(8)}$	

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, $\boldsymbol{if}$ $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}$ $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}$ $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a'_{42})^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a'_{42})^{(8)}t}\right] + G_{42}^0 e^{-(a'_{42})^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$

$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \le -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \le -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \le -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \le -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \le G_{44}(t) \le G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \le G_{45}(t) \le \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	
$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \le G_{46}(t) \le$ $\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t})$	
$T_{44}^0 e^{(R_1)^{(9)}t} \le T_{44}(t) \le T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \le T_{44}(t) \le \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \le T_{46}(t) \le$ $\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$ $(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$	
Proof : From global equations we obtain $\frac{dv^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14}, t)\right) - (a_{14}'')^{(1)}(T_{14}, t)v^{(1)} - (a_{14})^{(1)}v^{(1)}$ **Definition of** $v^{(1)}$:- $v^{(1)} = \frac{G_{13}}{G_{14}}$ It follows $-\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_2)^{(1)}v^{(1)} - (a_{13})^{(1)}\right) \le \frac{dv^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_1)^{(1)}v^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{v}_1)^{(1)}, (v_0)^{(1)}$:-	383

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have <u>**Definition of**</u> $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain <u>**Definition of**</u> $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	386

Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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<u>Definition of</u> $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
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If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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<u>**Particular case :**</u> If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
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From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
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If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:- $(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(3)}(t)$:- $(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case :	403

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **<u>Definition of</u>** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **<u>Definition of</u>** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	405
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

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If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case,

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

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If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right) - (a_{33}'')^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\le\frac{d\nu^{(6)}}{dt}\le-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\ge\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\le\nu^{(6)}(t)\le(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\le\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\le\nu^{(6)}(t)\le(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\le\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\le\ \nu^{(6)}(t)\le$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\le(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\le(\bar{\nu}_1)^{(6)}\le\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\le\ \nu^{(6)}(t)\le\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\le(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\le\ \nu^{(6)}(t)\le(m_1)^{(6)},\ \boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\le\ u^{(6)}(t)\le(\mu_1)^{(6)},\ \boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$**, and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have
<u>**Definition of**</u> $\nu^{(7)}(t)$:-

$$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(7)}(t)$:- 420

$$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>**Particular case :**</u>

If $(a_{36}'')^{(7)} = (a_{37}'')^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b_{36}'')^{(7)} = (b_{37}'')^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

<u>**Proof**</u> : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

<u>**Definition of**</u> $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .** Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.	
Proof : From 99,20,44,22,23,44 we obtain $\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}$, $\boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get $\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}$, $\boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$ From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$	
If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case, $(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$	

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$ if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$,

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$

with $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system

Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations 426

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$ 427

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$ 428

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$, 429

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)},(r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)},(r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)},(r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)},(r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

$with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (i) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*})=0$. With this value , we obtain from the three first equations	
$G_{16}=\frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18}=\frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*})=0$. With this value , we obtain from the three first equations $G_{20}=\frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22}=\frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*})=0$. With this value , we obtain from the three first equations $G_{24}=\frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26}=\frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*})=0$. With this value , we obtain from the three first equations $G_{28}=\frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}=\frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*})=0$. With this value , we obtain from the three first equations $G_{32}=\frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}=\frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	499
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*})=0$. With this value , we obtain from the three first equations $G_{36}=\frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}=\frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right] + (b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right] + (b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right] + (b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}')^{(8)} - (b_{40}'')^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}')^{(8)} - (b_{42}'')^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$	523 A

$T_{44}^{*} = \frac{(b_{44})^{(9)} T_{45}^{*}}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^{*})]}$, $T_{46}^{*} = \frac{(b_{46})^{(9)} T_{45}^{*}}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^{*})]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$ **:-** $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^{*}) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^{*}) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^{*}\mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^{*}\mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^{*}\mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^{*}\mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^{*}\mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^{*}\mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$ **:-**	
$G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^{*}) = (q_{17})^{(2)}$, $\frac{\partial (b_i'')^{(2)}}{\partial \mathbb{G}_j}((G_{19})^{*}) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^{*}\mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*}) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}'')^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i'')^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}')^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}')^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}')^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}')^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}')^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}')^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(5)}$ *and* $(b_i'')^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}'')^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i'')^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}((G_{35})^*) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)} G_{32}^* \mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)} G_{33}^* \mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)} G_{34}^* \mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)} T_{32}^* \mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)} T_{33}^* \mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)} T_{34}^* \mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}((G_{39})^{**}) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G_{36}^* \mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G_{37}^* \mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^{*}\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^{*}\mathbb{G}_{j}\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^{*}\mathbb{G}_{j}\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^{*}\mathbb{G}_{j}\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **<u>Theorem 8:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^{*}) = (q_{41})^{(8)} \quad , \frac{\partial (b_i^{''})^{(8)}}{\partial G_j}\left((G_{43})^{*}\right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^{*}\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^{*}\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}} (T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i'')^{(9)}}{\partial G_j} ((G_{47})^*) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)} G_{44}^* \mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)} G_{45}^* \mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)} G_{46}^* \mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)} T_{44}^* \mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)} T_{45}^* \mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)} T_{46}^* \mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)} G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)} T_{14}^* + (b_{14})^{(1)} s_{(13),(14)} T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}')^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)} G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)} G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)} T_{14}^* + (b_{14})^{(1)} s_{(13),(13)} T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$ $+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right) \left((a_{15})^{(1)}(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)} G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)} T_{14}^* + (b_{14})^{(1)} s_{(13),(15)} T_{13}^*\right)\} = 0$ +	

$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

+

$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$

$+\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$

+

$((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)})$

$\left[\left(((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$

$\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$

$+\left(((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$

$\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$

$\left(((\lambda)^{(4)})^{2} + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$

$\left(((\lambda)^{(4)})^{2} + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$

$+\left(((\lambda)^{(4)})^{2} + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$

$+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$

$\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$

+

$((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)})$

$\left[\left(((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$

$\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$

$+\left(((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$

$\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$

$\left(((\lambda)^{(5)})^{2} + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$

$\left(((\lambda)^{(5)})^{2} + \left((b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$

$+\left(((\lambda)^{(5)})^{2} + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$

$+((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$

$\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(30)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\} = 0$

+

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$((\lambda)^{(8)} + (b_{42}')^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a_{42}')^{(8)} + (p_{42})^{(8)})$

$\left[\left(((\lambda)^{(8)} + (a_{40}')^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(((\lambda)^{(8)} + (a_{41}')^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(((\lambda)^{(8)})^2 + ((a_{40}')^{(8)} + (a_{41}')^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})(\lambda)^{(8)}\right)$

$\left(((\lambda)^{(8)})^2 + ((b_{40}')^{(8)} + (b_{41}')^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)})(\lambda)^{(8)}\right)$

$+\left(((\lambda)^{(8)})^2 + ((a_{40}')^{(8)} + (a_{41}')^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+((\lambda)^{(8)} + (a_{40}')^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$

$+$

$((\lambda)^{(9)} + (b_{46}')^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a_{46}')^{(9)} + (p_{46})^{(9)})$

$\left[\left(((\lambda)^{(9)} + (a_{44}')^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$\left(((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(((\lambda)^{(9)} + (a_{45}')^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(((\lambda)^{(9)})^2 + ((a_{44}')^{(9)} + (a_{45}')^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})(\lambda)^{(9)}\right)$

$\left(((\lambda)^{(9)})^2 + ((b_{44}')^{(9)} + (b_{45}')^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)})(\lambda)^{(9)}\right)$

$+\left(((\lambda)^{(9)})^2 + ((a_{44}')^{(9)} + (a_{45}')^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+((\lambda)^{(9)} + (a_{44}')^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\} = 0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.	

SECTION TEN

Supersymmetric Yang-Mills Plasma

INTRODUCTION—VARIABLES USED

Photon and dilepton production in supersymmetric Yang-Mills plasma Simon Caron-Huot, Pavel Kovtun, Guy Moore, Andrei Starinets, Laurence G. Yaffe

(1) By weakly gauging one of the U(1) subgroups of (e) the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to (e&eb) electromagnetism, thus allowing (eb) a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling.

(2) Authors compute photon and dilepton emission rates from (e) finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to (e&eb) leading order, and non-perturbatively at (eb) strong coupling using (e) the AdS/CFT duality conjecture.

(3) Comparison of the photo-emission spectra for (e) N=4 plasma at weak coupling, N=4 plasma at (eb) strong coupling, and QCD at (eb) weak coupling reveals several systematic trends which they discuss.

(4) They also evaluate the electric conductivity of N=4 plasma in (eb) the strong coupling limit, and to leading-log order at (eb) weak coupling.

(5) Current-current spectral functions in the strongly coupled theory exhibit (eb) hydrodynamic peaks at small frequency, but otherwise show no (e) structure which could be (=) interpreted as well-defined thermal resonances in (eb) the high-temperature phase Subjects: High Energy Physics - Theory (hep-th); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) Journal reference: JHEP0612:015,2006 DOI: 10.1088/1126-6708/2006/12/015 Cite as: arXiv:hep-th/0607237 (or arXiv:hep-th/0607237v2 for this version)

Fluid/gravity correspondence and the CFM brane-world solutions Roberto Casadio, Rogerio T. Cavalcanti, Roldao da Rocha

(6) Authors consider the lower bound for (e) the shear viscosity-to-entropy ratio obtained from (e) the fluid/gravity correspondence in order to constrain (e) the post-Newtonian parameter of brane-world metrics.

(7) In particular, authors analyse the Casadio-Fabbri-Mazzacurati (CFM) effective solutions for (e) the gravity side of the correspondence and argue that including higher order terms in (eb) the hydrodynamic expansion can lead to (eb) a full agreement with (=) the experimental bounds for the Eddington-Robertson-Schiff post-Newtonian parameter of the CFM metrics.

(8) This lends further support to (eb) the physical relevance of (e) the viscosity-to-entropy ratio lower

bound and (e&eb) fluid/gravity correspondence overall. Subjects: High Energy Physics - Theory (hep-th); General Relativity and Quantum Cosmology (gr-qc) Cite as: arXiv: 1601.03222 [hep-th] (or arXiv: 1601.03222v1 [hep-th] for this version)

NOTATION

Module One

By weakly gauging one of the U(1) subgroups of (e) the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to (e&eb) electromagnetism, thus allowing (eb) a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling

G_{13} : Category one of **weakly gauging one of the U(1) subgroups;** R-symmetry group, N=4 super-Yang-Mills theory can be coupled to (e&eb) electromagnetism, thus allowing (eb) a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of R-symmetry group, N=4 super-Yang-Mills theory can be coupled to (e&eb) electromagnetism, thus allowing (eb) a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling; **weakly gauging one of the U(1) subgroups**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

By weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to (e&eb) electromagnetism, thus allowing (eb) a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling

G_{16} : Category one of **weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory;** electromagnetism, thus allowing (eb) a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of electromagnetism, thus allowing (eb) a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling **;weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory**

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

By weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to electromagnetism, thus allowing (eb) a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling

G_{20} : Category one of weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to electromagnetism

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

By weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to electromagnetism, thus allowing a computation of photon production and related phenomena in (eb) a QCD-like non-Abelian plasma at (eb) both weak and strong coupling

G_{24} : Category one of weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to electromagnetism, thus allowing a computation of photon production and related phenomena; **QCD-like non-Abelian plasma at (eb) both weak and strong coupling**

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of **QCD-like non-Abelian plasma at (eb) both weak and strong coupling** ;weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to electromagnetism, thus allowing a computation of photon production and related phenomena

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

By weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to electromagnetism, thus allowing a computation of photon production and related phenomena in a QCD-like non-Abelian plasma at (eb) both weak and strong coupling

G_{28} : Category one of weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to electromagnetism, thus allowing a computation of photon production and related phenomena in a QCD-like non-Abelian plasma; **weak and strong coupling**

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of **weak and strong coupling** ;weakly gauging one of the U(1) subgroups of the R-symmetry group, N=4 super-Yang-Mills theory can be coupled to electromagnetism, thus allowing a computation of photon production and related phenomena in a QCD-like non-Abelian plasma

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

Authors compute photon and dilepton emission rates from (e) finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to (e&eb) leading order, and non-perturbatively at (eb) strong coupling using (e) the AdS/CFT duality conjecture

G_{32} : Category one of finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to (e&eb) leading order, and non-perturbatively at (eb) strong coupling using (e) the AdS/CFT duality conjecture

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of photon and dilepton emission rates

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

Authors compute photon and dilepton emission rates from finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to (e&eb) leading order, and non-perturbatively at (eb) strong coupling using (e) the AdS/CFT duality conjecture

G_{36} : Category one of **photon and dilepton emission rates from finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling;** leading order, and non-perturbatively at (eb) strong coupling using (e) the AdS/CFT duality conjecture

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of leading order, and non-perturbatively at (eb) strong coupling using (e) the AdS/CFT duality conjecture **;photon and dilepton emission rates from finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling**

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

Authors compute photon and dilepton emission rates from finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to leading order, and non-perturbatively at (eb) strong coupling using (e) the AdS/CFT duality conjecture

G_{40} : Category one of photon and dilepton emission rates from finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to leading order, and non-perturbatively; **strong coupling using (e) the AdS/CFT duality conjecture**

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of **strong coupling using (e) the AdS/CFT duality conjecture** ; photon and dilepton emission rates from finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to leading order, and non-perturbatively

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

Authors compute photon and dilepton emission rates from finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to leading order, and non-perturbatively at strong coupling using (e) the AdS/CFT duality conjecture

G_{44} : Category one of AdS/CFT duality conjecture

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of photon and dilepton emission rates from finite temperature N=4 supersymmetric Yang-Mills plasma both perturbatively at weak coupling to leading order, and non-perturbatively at strong coupling

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$	

$(a_{24}^{'})^{(4)}, (a_{25}^{'})^{(4)}, (a_{26}^{'})^{(4)}, (b_{24}^{'})^{(4)}, (b_{25}^{'})^{(4)}, (b_{26}^{'})^{(4)}, (b_{28}^{'})^{(5)}, (b_{29}^{'})^{(5)}, (b_{30}^{'})^{(5)}\ (a_{28}^{'})^{(5)}, (a_{29}^{'})^{(5)}, (a_{30}^{'})^{(5)}$, $(a_{32}^{'})^{(6)}, (a_{33}^{'})^{(6)}, (a_{34}^{'})^{(6)}, (b_{32}^{'})^{(6)}, (b_{33}^{'})^{(6)}, (b_{34}^{'})^{(6)}$ $(a_{36}^{'})^{(7)}, (a_{37}^{'})^{(7)}, (a_{38}^{'})^{(7)}, (b_{36}^{'})^{(7)}, (b_{37}^{'})^{(7)}, (b_{38}^{'})^{(7)},$ $(a_{40}^{'})^{(8)}, (a_{41}^{'})^{(8)}, (a_{42}^{'})^{(8)}, (b_{40}^{'})^{(8)}, (b_{41}^{'})^{(8)}, (b_{42}^{'})^{(8)},$ $(a_{44}^{'})^{(9)}, (a_{45}^{'})^{(9)}, (a_{46}^{'})^{(9)}, (b_{44}^{'})^{(9)}, (b_{45}^{'})^{(9)}, (b_{46}^{'})^{(9)},$ are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\big((G_{19}),t\big) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18

$+(a''_{20})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a''_{24})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37

$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}, t) \right] G_{37}$	38
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}, t) \right] G_{38}$	39
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)} ((G_{39}), t) \right] T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)} ((G_{39}), t) \right] T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)} ((G_{39}), t) \right] T_{38}$	42
$+(a''_{36})^{(7)} (T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)} (T_{41}, t) \right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}, t) \right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)} ((G_{43}), t) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)} ((G_{43}), t) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)} ((G_{43}), t) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)} (T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)} (T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)} (T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)} ((G_{47}), t) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)} ((G_{47}), t) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)} ((G_{47}), t) \right] T_{46}$	54
$+(a''_{44})^{(9)} (T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)} ((G_{47}), t) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)} (T_{14}, t)} \boxed{+(a''_{16})^{(2,2,)} (T_{17}, t)} \boxed{+(a''_{20})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a''_{28})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a''_{32})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a''_{36})^{(7,7)} (T_{37}, t)} \boxed{+(a''_{40})^{(8,8)} (T_{41}, t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{matrix} \right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)} (T_{14}, t)} \boxed{+(a''_{17})^{(2,2,)} (T_{17}, t)} \boxed{+(a''_{21})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a''_{29})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a''_{33})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a''_{37})^{(7,7)} (T_{37}, t)} \boxed{+(a''_{41})^{(8,8)} (T_{41}, t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{matrix} \right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)} (T_{14}, t)} \boxed{+(a''_{18})^{(2,2,)} (T_{17}, t)} \boxed{+(a''_{22})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a''_{30})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a''_{34})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a''_{38})^{(7,7)} (T_{37}, t)} \boxed{+(a''_{42})^{(8,8)} (T_{41}, t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{matrix} \right] G_{15}$	57
Where $\boxed{(a''_{13})^{(1)} (T_{14}, t)}$, $\boxed{(a''_{14})^{(1)} (T_{14}, t)}$, $\boxed{(a''_{15})^{(1)} (T_{14}, t)}$ are first augmentation coefficients for	

category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{array}{c} (b'_{13})^{(1)}\boxed{-(b''_{13})^{(1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{13} \quad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{array}{c} (b'_{14})^{(1)}\boxed{-(b''_{14})^{(1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{14} \quad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{array}{c} (b'_{15})^{(1)}\boxed{-(b''_{15})^{(1)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{15} \quad 60$$

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	64

$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\begin{bmatrix}(b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,)}(G,t)}\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}\end{bmatrix}T_{17}$	65
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\begin{bmatrix}(b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,)}(G,t)}\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}\end{bmatrix}T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\begin{bmatrix}(a'_{20})^{(3)}\boxed{+(a''_{20})^{(3)}(T_{21},t)}\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{20}$	67
$\frac{dG_{21}}{dt}=(a_{21})^{(3)}G_{20}-\begin{bmatrix}(a'_{21})^{(3)}\boxed{+(a''_{21})^{(3)}(T_{21},t)}\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{21}$	68
$\frac{dG_{22}}{dt}=(a_{22})^{(3)}G_{21}-\begin{bmatrix}(a'_{22})^{(3)}\boxed{+(a''_{22})^{(3)}(T_{21},t)}\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$ $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t) + (a''_{28})^{(5,5,)}(T_{29},t) + (a''_{32})^{(6,6,)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1)}(T_{14},t) + (a''_{16})^{(2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{36})^{(7,7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8,8)}(T_{41},t) + (a''_{44})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{24}$$ 73

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25},t) + (a''_{29})^{(5,5,)}(T_{29},t) + (a''_{33})^{(6,6)}(T_{33},t) \\ +(a''_{14})^{(1,1,1,1)}(T_{14},t) + (a''_{17})^{(2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{37})^{(7,7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{25}$$ 74

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25},t) + (a''_{30})^{(5,5,)}(T_{29},t) + (a''_{34})^{(6,6,)}(T_{33},t) \\ +(a''_{15})^{(1,1,1,1)}(T_{14},t) + (a''_{18})^{(2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{38})^{(7,7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{26}$$ 75

$(a''_{24})^{(4)}(T_{25},t)$, $(a''_{25})^{(4)}(T_{25},t)$, $(a''_{26})^{(4)}(T_{25},t)$ *are first augmentation coefficients category* 1, 2 3

$+(a''_{28})^{(5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3

$+(a''_{32})^{(6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3

$+(a''_{13})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1)}(T_{14},t)$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{16})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2)}(T_{17},t)$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{20})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3)}(T_{21},t)$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{46})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9)}(T_{45},t)$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27},t) - (b''_{28})^{(5,5,)}(G_{31},t) - (b''_{32})^{(6,6,)}(G_{35},t) \\ -(b''_{13})^{(1,1,1,1)}(G,t) - (b''_{16})^{(2,2,2,2)}(G_{19},t) - (b''_{20})^{(3,3,3,3)}(G_{23},t) \\ -(b''_{36})^{(7,7,7,7,7)}(G_{39},t) - (b''_{40})^{(8,8,8,8,8)}(G_{43},t) - (b''_{44})^{(9,9,9,9)}(G_{47},t) \end{bmatrix} T_{24}$$ 76

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25}$$	77
$$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$$	79
$$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$$	80
$$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation*	

coefficient for category 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{28}$$	82
$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{29}$$	83
$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{30}$$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition	

coefficients for category 1,2, and 3

$\boxed{-(b_{42}'')^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}'')^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b_{46}'')^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a_{32}')^{(6)} \boxed{+(a_{32}'')^{(6)}(T_{33},t)} \boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32} \quad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a_{33}')^{(6)} \boxed{+(a_{33}'')^{(6)}(T_{33},t)} \boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a_{34}')^{(6)} \boxed{+(a_{34}'')^{(6)}(T_{33},t)} \boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34} \quad 87$$

$\boxed{+(a_{32}'')^{(6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a_{16}'')^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a_{20}'')^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a_{44}'')^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b_{32}')^{(6)} \boxed{-(b_{32}'')^{(6)}(G_{35},t)} \boxed{-(b_{28}'')^{(5,5,5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$$	89
$$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$	91
$$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$	92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \qquad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$
are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \qquad 94$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix}(a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right] G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix}(a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right] G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix}(a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right] G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} =$$

$$(b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t) + (a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{13}$	96
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t) + (a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{37},t) + (a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{15}$	
Where $+(a''_{44})^{(9)}(T_{45},t)$, $+(a''_{45})^{(9)}(T_{45},t)$, $+(a''_{46})^{(9)}(T_{37},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b_{44}')^{(9)}\boxed{-(b_{44}'')^{(9)}(G_{47},t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b_{45}')^{(9)}\boxed{-(b_{45}'')^{(9)}(G_{47},t)} \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}')^{(9)}\boxed{-(b_{46}'')^{(9)}(G_{47},t)} \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b_{44}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i')^{(1)}, (a_i'')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (b_i'')^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i'')^{(1)}, (b_i'')^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)},$ are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i')^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i')^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0,\quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)},\ (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t)\le(p_i)^{(2)}\le(\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t)\le\ (r_i)^{(2)}\le(b_i')^{(2)}\le(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}((G_{19}),t)=\ (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	
$\|(a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\|\le(\hat{k}_{16})^{(2)}\|T_{17}-T_{17}'\|e^{-(\hat{M}_{16})^{(2)}t}$	107
$\|(b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\|<(\hat{k}_{16})^{(2)}\|\|(G_{19})-(G_{19})'\|\|e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},$ are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)} + (a_i^{'})^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i^{'})^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty} (a_i^{''})^{(3)}\ (T_{21}, t) = (p_i)^{(3)}$ $\mathrm{lim}_{\mathrm{G}\to\infty} (b_i^{''})^{(3)}\ (G_{23}, t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20,21,22}$	113
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and $(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}\ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'}, t)$ and$(a_i^{''})^{(4)}(T_{25}, t)$. $(T_{25}^{'}, t)$ and (T_{25}, t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}, \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

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Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
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Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants	129

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(CCC) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (DDD) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
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They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)} t}$ $\lvert(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\rvert < (\hat{k}_{36})^{(7)} \lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
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Where we suppose	
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The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
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$\lim_{G \to \infty} (b_i'')^{(8)} \left((G_{43}), t\right) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t)\rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}' \rvert e^{-(\hat{M}_{40})^{(8)} t}$	142

$\lvert (b_i'')^{(8)}((G_{43})',t)-(b_i'')^{(8)}((G_{43}),t)\rvert < (\hat{k}_{40})^{(8)} \lvert\lvert (G_{43})-(G_{43})' \rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
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Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
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$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
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$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t)= (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition:	

$|(a_i'')^{(9)}(T_{45}',t) - (a_i'')^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$

$|(b_i'')^{(9)}((G_{47})',t) - (b_i'')^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and$(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0), T_i(0)$:

$G_i(t) \leq (\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$

$T_i(t) \leq (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0), T_i(0)$

$G_i(t) \leq (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$

$T_i(t) \leq (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$G_i(t) \leq (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$

$T_i(t) \leq \ (\hat{Q}_{20} \ )^{(3)} e^{(\hat{M}_{20} \ )^{(3)} t} \quad , \quad T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) \, , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{24} \ )^{(4)} e^{(\hat{M}_{24} \ )^{(4)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24} \ )^{(4)} e^{(\hat{M}_{24} \ )^{(4)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) \, , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{28} \ )^{(5)} e^{(\hat{M}_{28} \ )^{(5)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{28} \ )^{(5)} e^{(\hat{M}_{28} \ )^{(5)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) \, , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{32} \ )^{(6)} e^{(\hat{M}_{32} \ )^{(6)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{32} \ )^{(6)} e^{(\hat{M}_{32} \ )^{(6)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) \, , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{36} \ )^{(7)} e^{(\hat{M}_{36} \ )^{(7)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{36} \ )^{(7)} e^{(\hat{M}_{36} \ )^{(7)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) \, , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{40} \ )^{(8)} e^{(\hat{M}_{40} \ )^{(8)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{40} \ )^{(8)} e^{(\hat{M}_{40} \ )^{(8)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) \, , T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44}\right)^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{\mathrm{T}}_{26}(\mathrm{t}) = \mathrm{T}_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \le (\,\hat{P}_{32}\,)^{(6)} \,, T_i^0 \le (\,\hat{Q}_{32}\,)^{(6)}$,	
$0 \le G_i(t) - G_i^0 \le (\,\hat{P}_{32}\,)^{(6)} e^{(\,\hat{M}_{32}\,)^{(6)} t}$	
$0 \le T_i(t) - T_i^0 \le (\,\hat{Q}_{32}\,)^{(6)} e^{(\,\hat{M}_{32}\,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i\,, T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \le (\,\hat{P}_{36}\,)^{(7)} \,, T_i^0 \le (\,\hat{Q}_{36}\,)^{(7)}$,	
$0 \le G_i(t) - G_i^0 \le (\,\hat{P}_{36}\,)^{(7)} e^{(\,\hat{M}_{36}\,)^{(7)} t}$	
$0 \le T_i(t) - T_i^0 \le (\,\hat{Q}_{36}\,)^{(7)} e^{(\,\hat{M}_{36}\,)^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}')^{(7)} - (b_{37}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}')^{(7)} - (b_{38}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}')^{(8)} + a_{40}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}')^{(8)} + (a_{41}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}')^{(8)} + (a_{42}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}')^{(8)} - (b_{40}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}')^{(8)} - (b_{41}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}')^{(8)} - (b_{42}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
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$$(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$$

(G_i^0) is as defined in the statement of theorem 6

Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$

(j) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 178

$$G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right] ds_{(36)} =$$

$$\left(1+(a_{36})^{(7)}t\right)G_{37}^0 + \frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$$

From which it follows that

$$(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$$

(G_i^0) is as defined in the statement of theorem 7

The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that

$$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)}\left(G_{41}^0+(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right] ds_{(40)} =$$ 180

$$\left(1+(a_{40})^{(8)}t\right)G_{41}^0 + \frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$$

From which it follows that 181

$$(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$$

(G_i^0) is as defined in the statement of theorem 8

Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$

The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that

$$G_{44}(t) \leq G_{44}^0 + \int_0^t \left[(a_{44})^{(9)}\left(G_{45}^0+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right] ds_{(44)} =$$

$$\left(1+(a_{44})^{(9)}t\right)G_{45}^0 + \frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$$

From which it follows that

$$(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$$

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And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 1: The fact that we supposed $(a_{13}^{''})^{(1)}$ and $(b_{13}^{''})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ *and* $(\widehat{Q}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(1)}$ and $(b_i^{''})^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i\,(t) = 0$ *and* $T_i\,(t) = 0$

From 19 to 24 it results

$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(1)} - (a_i^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\} ds_{(13)}\right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(1)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{13})^{(1)}\right)_1, \left((\widehat{M}_{13})^{(1)}\right)_2$ *and* $\left((\widehat{M}_{13})^{(1)}\right)_3$: 187

Remark 3: if G_{13} is bounded, the same property have also G_{14} *and* G_{15} . indeed if

$G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \leq \left((\widehat{M}_{13})^{(1)}\right)_1 - (a_{14}^{'})^{(1)} G_{14}$ and by integrating

$$G_{14} \leq \left((\widehat{M}_{13})^{(1)}\right)_2 = G_{14}^0 + 2(a_{14})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_1 / (a_{14}^{'})^{(1)}$$

In the same way , one can obtain

$$G_{15} \leq \left((\widehat{M}_{13})^{(1)}\right)_3 = G_{15}^0 + 2(a_{15})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_2 / (a_{15}^{'})^{(1)}$$

If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.

Remark 4: If G_{13} *is* bounded, from below, the same property holds for G_{14} *and* G_{15} . The proof is 188
analogous with the preceding one. An analogous property is true if G_{14} is bounded from below.

Remark 5: If T_{13} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(1)}(G(t),t)) = (b_{14}^{'})^{(1)}$ then $T_{14} \to \infty$. 189

Definition of $(m)^{(1)}$ and ε_1 :

Indeed let t_1 be so that for $t > t_1$

$$(b_{14})^{(1)} - (b_i^{''})^{(1)}(G(t),t) < \varepsilon_1, T_{13}\,(t) > (m)^{(1)}$$

Then $\frac{dT_{14}}{dt} \geq (a_{14})^{(1)}(m)^{(1)} - \varepsilon_1 T_{14}$ which leads to

$T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{\varepsilon_1}\right)(1 - e^{-\varepsilon_1 t}) + T_{14}^0 e^{-\varepsilon_1 t}$ If we take t such that $e^{-\varepsilon_1 t} = \frac{1}{2}$ it results

$T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{2}\right), \quad t = log\frac{2}{\varepsilon_1}$ By taking now ε_1 sufficiently small one sees that T_{14} is unbounded. The same property holds for T_{15} if $\lim_{t\to\infty}(b_{15}^{''})^{(1)}(G(t),t) = (b_{15}^{'})^{(1)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	
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$\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}\left[(\hat{P}_{20})^{(3)} + \left((\hat{P}_{20})^{(3)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{20})^{(3)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{20})^{(3)}$	208
$\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{Q}_{20})^{(3)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{20})^{(3)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{20})^{(3)}\right] \leq (\hat{Q}_{20})^{(3)}$	209
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$\left\|(G_{27})^{(1)}-(G_{27})^{(2)}\right\|e^{-(\widehat{M}_{24})^{(4)}t} \leq$ $\frac{1}{(\widehat{M}_{24})^{(4)}}\left((a_{24})^{(4)}+(a_{24}^{'})^{(4)}+(\widehat{A}_{24})^{(4)}+(\widehat{P}_{24})^{(4)}(\widehat{k}_{24})^{(4)}\right)d\left(\left((G_{27})^{(1)},(T_{27})^{(1)};\ (G_{27})^{(2)},(T_{27})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	226
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Remark 17: There does not exist any t where $G_i\ (t) = 0$ *and* $T_i\ (t) = 0$ it results $G_i\ (t) \geq G_i^0 e^{\left[-\int_0^t\{(a_i^{'})^{(4)}-(a_i^{''})^{(4)}(T_{25}(s_{(24)}),s_{(24)})\}ds_{(24)}\right]} \geq 0$ $T_i\ (t) \geq T_i^0 e^{(-(b_i^{'})^{(4)}t)} > 0$ for t > 0	228
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Where $s_{(28)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on it follows

$$\left|(G_{31})^{(1)} - (G_{31})^{(2)}\right| e^{-(\widehat{M}_{28})^{(5)}t} \leq \frac{1}{(\widehat{M}_{28})^{(5)}}\left((a_{28})^{(5)} + (a_{28}^{'})^{(5)} + (\widehat{A}_{28})^{(5)} + (\widehat{P}_{28})^{(5)}(\widehat{k}_{28})^{(5)}\right)d\left(\left((G_{31})^{(1)}, (T_{31})^{(1)}; (G_{31})^{(2)}, (T_{31})^{(2)}\right)\right)$$ 237

And analogous inequalities for G_i and T_i. Taking into account the hypothesis the result follows

Remark 21: The fact that we supposed $(a_{28}^{''})^{(5)}$ and $(b_{28}^{''})^{(5)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{28})^{(5)} e^{(\widehat{M}_{28})^{(5)}t}$ and $(\widehat{Q}_{28})^{(5)} e^{(\widehat{M}_{28})^{(5)}t}$ respectively of $\mathbb{R}_+$. 238

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(5)}$ and $(b_i^{''})^{(5)}, i = 28,29,30$ depend only on T_{29} and respectively on $(G_{31})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 22: There does not exist any t where $G_i\,(t) = 0$ and $T_i\,(t) = 0$ 239

it results

$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(5)} - (a_i^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\} ds_{(28)}\right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(5)}t\right)} > 0 \quad \text{for } \mathrm{t} > 0$$

Definition of $\left((\widehat{M}_{28})^{(5)}\right)_1, \left((\widehat{M}_{28})^{(5)}\right)_2$ and $\left((\widehat{M}_{28})^{(5)}\right)_3$: 240

Remark 23: if G_{28} is bounded, the same property have also G_{29} and G_{30} . indeed if

$G_{28} < (\widehat{M}_{28})^{(5)}$ it follows $\frac{dG_{29}}{dt} \leq \left((\widehat{M}_{28})^{(5)}\right)_1 - (a_{29}^{'})^{(5)} G_{29}$ and by integrating

$$G_{29} \leq \left((\widehat{M}_{28})^{(5)}\right)_2 = G_{29}^0 + 2(a_{29})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_1 / (a_{29}^{'})^{(5)}$$

In the same way , one can obtain

$$G_{30} \leq \left((\widehat{M}_{28})^{(5)}\right)_3 = G_{30}^0 + 2(a_{30})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_2 / (a_{30}^{'})^{(5)}$$

If G_{29} or G_{30} is bounded, the same property follows for G_{28} , G_{30} and G_{28} , G_{29} respectively.

Remark 24: If G_{28} is bounded, from below, the same property holds for G_{29} and G_{30} . The proof is analogous with the preceding one. An analogous property is true if G_{29} is bounded from below. 241

Remark 25: If T_{28} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(5)}((G_{31})(t), t)) = (b_{29}^{'})^{(5)}$ then $T_{29} \to \infty$. 242

Definition of $(m)^{(5)}$ and ε_5 :

Indeed let t_5 be so that for $t > t_5$

$(b_{29})^{(5)} - (b_i'')^{(5)}((G_{31})(t), t) < \varepsilon_5, T_{28}\ (t) > (m)^{(5)}$	
Then $\frac{dT_{29}}{dt} \geq (a_{29})^{(5)}(m)^{(5)} - \varepsilon_5 T_{29}$ which leads to $T_{29}\ \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{\varepsilon_5}\right)(1 - e^{-\varepsilon_5 t}) + T_{29}^0 e^{-\varepsilon_5 t}$ If we take t such that $e^{-\varepsilon_5 t} = \frac{1}{2}$ it results $T_{29}\ \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{2}\right),\quad t = log\frac{2}{\varepsilon_5}$ By taking now ε_5 sufficiently small one sees that T_{29} is unbounded. The same property holds for T_{30} if $\lim_{t\to\infty}(b_{30}'')^{(5)}\left((G_{31})(t), t\right) = (b_{30}')^{(5)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations Analogous inequalities hold also for $G_{33}\ , G_{34}, T_{32}, T_{33}, T_{34}$	243
It is now sufficient to take $\frac{(a_i)^{(6)}}{(\mathcal{M}_{32}\ )^{(6)}}\ , \frac{(b_i)^{(6)}}{(\mathcal{M}_{32}\ )^{(6)}} < 1$ and to choose $(\ \widehat{P}_{32}\ )^{(6)}$ and $(\ \widehat{Q}_{32}\ )^{(6)}$ large to have	244
$\frac{(a_i)^{(6)}}{(\mathcal{M}_{32})^{(6)}}\left[(\widehat{P}_{32})^{(6)} + ((\widehat{P}_{32}\ )^{(6)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{32}\ )^{(6)}+G_j^0}{G_j^0}\right)}\right] \leq (\ \widehat{P}_{32}\ )^{(6)}$	245
$\frac{(b_i)^{(6)}}{(\mathcal{M}_{32})^{(6)}}\left[((\ \widehat{Q}_{32}\ )^{(6)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{32}\ )^{(6)}+T_j^0}{T_j^0}\right)} + (\ \widehat{Q}_{32}\ )^{(6)}\right] \leq (\ \widehat{Q}_{32}\ )^{(6)}$	246
In order that the operator $\mathcal{A}^{(6)}$ transforms the space of sextuples of functions $G_i\ , T_i$ satisfying Equations into itself	
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$G_{32}^{(2)}\|(a_{32}'')^{(6)}(T_{33}^{(1)},s_{(32)})-(a_{32}'')^{(6)}(T_{33}^{(2)},s_{(32)})\|\ e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$ Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	
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Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(7)}((G_{39})(t),t)) = (b_{37}^{'})^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i^{''})^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$	264
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$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
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The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
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Indeed if we denote **Definition of** $\widetilde{(G_{43})}, \widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results	271

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Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
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Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}')^{(8)}$	276

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
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Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\left((G_{43})(t),t(t),t\right) = (b_{42}')^{(8)}$	279
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(\left((G_{47})^{(1)},(T_{47})^{(1)}\right),\left((G_{47})^{(2)},(T_{47})^{(2)}\right)\right) = \sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t) - G_i^{(2)}(t)\right\|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t) - T_i^{(2)}(t)\right\|e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})}, \widetilde{(T_{47})} : \left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}),(T_{47})\right)$ It results	

$|\tilde{G}_{44}^{(1)} - \tilde{G}_{i}^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widetilde{M}_{44})^{(9)} s_{(44)}} e^{(\widetilde{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$
$\int_0^t \{(a'_{44})^{(9)} |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widetilde{M}_{44})^{(9)} s_{(44)}} e^{-(\widetilde{M}_{44})^{(9)} s_{(44)}} +$
$(a''_{44})^{(9)} (T_{45}^{(1)}, s_{(44)}) |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widetilde{M}_{44})^{(9)} s_{(44)}} e^{(\widetilde{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)} |(a''_{44})^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a''_{44})^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widetilde{M}_{44})^{(9)} s_{(44)}} e^{(\widetilde{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}| e^{-(\widetilde{M}_{44})^{(9)} t} \leq$$
$$\frac{1}{(\widetilde{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)} \right) d \left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)} \right) \right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{ (a'_i)^{(9)} - (a''_i)^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \} ds_{(44)} \right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b'_i)^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $((\widehat{M}_{44})^{(9)})_1, ((\widehat{M}_{44})^{(9)})_2$ *and* $((\widehat{M}_{44})^{(9)})_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq ((\widehat{M}_{44})^{(9)})_1 - (a'_{45})^{(9)} G_{45}$ and by integrating

$$G_{45} \leq ((\widehat{M}_{44})^{(9)})_2 = G_{45}^0 + 2(a_{45})^{(9)} ((\widehat{M}_{44})^{(9)})_1 / (a'_{45})^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq ((\widehat{M}_{44})^{(9)})_3 = G_{46}^0 + 2(a_{46})^{(9)} ((\widehat{M}_{44})^{(9)})_2 / (a'_{46})^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t),t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $$(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t),t) = (b_{46}')^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14},t) + (a_{14}'')^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b_{13}')^{(1)} + (b_{14}')^{(1)} - (b_{13}'')^{(1)}(G,t) - (b_{14}'')^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$	283

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}((G_{19}), t) - (b''_{17})^{(2)}((G_{19}), t) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}(u^{(2)})^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}(u^{(2)})^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}$, ***if*** $(\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}$, ***if*** $(\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}$, ***if*** $(\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}$, ***if*** $(u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}$, ***if*** $(u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}$, ***if*** $(\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^{0} e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^{0} e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^{0} e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_2)^{(2)}((S_1)^{(2)}-(a'_{18})^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a'_{18})^{(2)}t}\right] + G_{18}^{0} e^{-(a'_{18})^{(2)}t}\right)$	312
$\boxed{T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^{0}}{(\mu_1)^{(2)}((R_1)^{(2)}-(b'_{18})^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b'_{18})^{(2)}t}\right] + T_{18}^{0} e^{-(b'_{18})^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^{0}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^{0} e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a'_{16})^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b'_{16})^{(2)}$ $(R_2)^{(2)} = (b'_{18})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a'_{20})^{(3)} + (a'_{21})^{(3)} - (a''_{20})^{(3)}(T_{21}, t) + (a''_{21})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b'_{20})^{(3)} + (b'_{21})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) - (b''_{21})^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
Definition of $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)}$, $\boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}$, $\boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)}$, $\boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}$, $\boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}$, $\boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}$, $\boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})}\left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq \right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a'_{22})^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a'_{22})^{(3)}t}\right] + G_{22}^0 e^{-(a'_{22})^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)} - (b'_{22})^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b'_{22})^{(3)}t}\right] + T_{22}^0 e^{-(b'_{22})^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)})}\left[e^{((R_1)^{(3)} + (r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)},\ \boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)},\ \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}\left((R_1)^{(4)}-(b'_{26})^{(4)}\right)}\left[e^{(R_1)^{(4)}t} - e^{-(b'_{26})^{(4)}t}\right] + T_{26}^0 e^{-(b'_{26})^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}\left((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)}\right)}\left[e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
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Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a'_{28})^{(5)} + (a'_{29})^{(5)} - (a''_{28})^{(5)}(T_{29}, t) + (a''_{29})^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b'_{28})^{(5)} + (b'_{29})^{(5)} - (b''_{28})^{(5)}\left((G_{31}), t\right) - (b''_{29})^{(5)}\left((G_{31}), t\right) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)}, , (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}$, ***if*** $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
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Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)}-(p_{28})^{(5)}\right)t} \le G_{28}(t) \le G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)}-(p_{28})^{(5)}\right)t} \le G_{29}(t) \le \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)}G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)}-(p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \le G_{30}(t) \le\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le T_{28}^0 e^{\left((R_1)^{(5)}+(r_{28})^{(5)}\right)t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)}+(r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b_{30}')^{(5)}t}\right]+T_{30}^0e^{-(b_{30}')^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0e^{-(R_2)^{(5)}t}$	347
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<u>Definition of</u> $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **<u>Definition of</u>** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},$ ***if*** $(\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)}$, ***if*** $(\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},$ ***if*** $(\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
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$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b'_{34})^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b'_{34})^{(6)}t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
<u>**Definition of**</u> $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a'_{32})^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b'_{32})^{(6)}$ $(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$	359
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},$ ***if*** $(\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},$ ***if*** $(\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},$ ***if*** $(\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},$ ***if*** $(u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)},$ ***if*** $(u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)},$ ***if*** $(\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t}-e^{-(S_2)^{(7)}t}\right]+G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t}-e^{-(a_{38}')^{(7)}t}]+ G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t}-e^{-(b_{38}')^{(7)}t}\right]+T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^0 e^{-(R_2)^{(7)}t}$	369
<u>**Definition of**</u> $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}')^{(7)}$ $(R_2)^{(7)} = (b_{38}')^{(7)} - (r_{38})^{(7)}$	370
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}')^{(8)} + (a_{41}')^{(8)} - (a_{40}'')^{(8)}(T_{41}, t) + (a_{41}'')^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}')^{(8)} + (b_{41}')^{(8)} - (b_{40}'')^{(8)}((G_{43}), t) - (b_{41}'')^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
<u>**Definition of**</u> $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}(\nu^{(8)})^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_1)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ and	
Definition of $(\bar{\nu}_1)^{(8)},,(\bar{\nu}_2)^{(8)},(\bar{u}_1)^{(8)},(\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)}>0\,,(\bar{\nu}_2)^{(8)}<0$ and respectively $(\bar{u}_1)^{(8)}>0\,,(\bar{u}_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_2)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_2)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ **Definition of** $(m_1)^{(8)}\,,(m_2)^{(8)}\,,(\mu_1)^{(8)},(\mu_2)^{(8)},(\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}\,,(m_2)^{(8)}\,,(\mu_1)^{(8)},(\mu_2)^{(8)}$ by $(m_2)^{(8)}=(\nu_0)^{(8)},(m_1)^{(8)}=(\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)}<(\nu_1)^{(8)}$ $(m_2)^{(8)}=(\nu_1)^{(8)},(m_1)^{(8)}=(\bar{\nu}_1)^{(8)}\,,\boldsymbol{if}\ (\nu_1)^{(8)}<(\nu_0)^{(8)}<(\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)}=\frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)}=(\nu_1)^{(8)},(m_1)^{(8)}=(\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)}<(\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)}=(u_0)^{(8)},(\mu_1)^{(8)}=(u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)}<(u_1)^{(8)}$ $(\mu_2)^{(8)}=(u_1)^{(8)},(\mu_1)^{(8)}=(\bar{u}_1)^{(8)}\,,\boldsymbol{if}\ (u_1)^{(8)}<(u_0)^{(8)}<(\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)}=\frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)}=(u_1)^{(8)},(\mu_1)^{(8)}=(u_0)^{(8)},\boldsymbol{if}\ (\bar{u}_1)^{(8)}<(u_0)^{(8)}$ where $(u_1)^{(8)},(\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0e^{((S_1)^{(8)}-(p_{40})^{(8)})t}\le G_{40}(t)\le G_{40}^0e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}}G_{40}^0e^{((S_1)^{(8)}-(p_{40})^{(8)})t}\le G_{41}(t)\le\frac{1}{(m_2)^{(8)}}G_{40}^0e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t}-e^{-(S_2)^{(8)}t}\right]+G_{42}^0e^{-(S_2)^{(8)}t}\le G_{42}(t)\le\right.$ $\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t}-e^{-(a_{42}')^{(8)}t}\right]+G_{42}^0e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a_{44}')^{(9)} + (a_{45}')^{(9)} - (a_{44}'')^{(9)}(T_{45}, t) + (a_{45}'')^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b_{44}')^{(9)} + (b_{45}')^{(9)} - (b_{44}'')^{(9)}\big((G_{47}), t\big) - (b_{45}'')^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},$ ***if*** $(\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, **if** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, **if** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, **if** $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, **if** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, **if** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \le G_{44}(t) \le G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \le G_{45}(t) \le \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \le G_{46}(t) \le$$
$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t}\Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \le T_{44}(t) \le T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \le T_{44}(t) \le \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \le T_{46}(t) \le$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have **<u>Definition of</u>** $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **<u>Definition of</u>** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. <u>Particular case :</u> If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
<u>Definition of</u> $\nu^{(2)}$:- $\quad \boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
From which one obtains **<u>Definition of</u>** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)}=\frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0<(\nu_1)^{(2)}<(\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}<(\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0<(\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t)=\frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t)=\frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)}=(a''_{17})^{(2)}, then\ (\sigma_1)^{(2)}=(\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)}=(\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)}=(\nu_1)^{(2)}$ then $\nu^{(2)}(t)=(\nu_0)^{(2)}$ and as a consequence $G_{16}(t)=(\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)}=(b''_{17})^{(2)}, then\ (\tau_1)^{(2)}=(\tau_2)^{(2)}$ and then $(u_1)^{(2)}=(\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)}=(u_1)^{(2)}$ then $T_{16}(t)=(u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}')^{(3)} - (a_{21}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right) - (a_{21}'')^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{24}'')^{(4)} = (a_{25}'')^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b_{24}'')^{(4)} = (b_{25}'')^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}')^{(5)} - (a_{29}')^{(5)} + (a_{28}'')^{(5)}(T_{29}, t)\right) - (a_{29}'')^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\le\frac{d\nu^{(5)}}{dt}\le-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\ge\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\le\nu^{(5)}(t)\le(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\le\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\le\nu^{(5)}(t)\le(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\le\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\le\nu^{(5)}(t)\le$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\le(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\le(\bar{\nu}_1)^{(5)}\le\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\le\nu^{(5)}(t)\le\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\le(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\le\nu^{(5)}(t)\le(m_1)^{(5)}$, $\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\le u^{(5)}(t)\le(\mu_1)^{(5)}$, $\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

<u>Proof</u> : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right) - (a_{33}'')^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

<u>Definition of</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

<u>Definition of</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .** Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.	
Proof : From 99,20,44,22,23,44 we obtain $$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}$, $\boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get	

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)}=\frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t)=\frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t)=\frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$**, and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}')^{(1)}(r_{14})^{(1)} - (b_{14}')^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ \ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i'')^{(2)} and\ (b_i'')^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}')^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}')^{(2)}(r_{17})^{(2)} - (b_{17}')^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i'')^{(3)} and\ (b_i'')^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}')^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}')^{(3)}(r_{21})^{(3)} - (b_{21}')^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i'')^{(4)} and\ (b_i'')^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}')^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}')^{(4)}(r_{25})^{(4)} - (b_{25}')^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i'')^{(5)} and\ (b_i'')^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}')^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}>0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}-(b_{44}^{'})^{(9)}(r_{45})^{(9)}-(b_{45}^{'})^{(9)}(r_{45})^{(9)}+(r_{44})^{(9)}(r_{45})^{(9)}<0$ $with\ (p_{44})^{(9)},(r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14}-\left[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14})\right]G_{13}=0$	437
$(a_{14})^{(1)}G_{13}-\left[(a_{14}^{'})^{(1)}+(a_{14}^{''})^{(1)}(T_{14})\right]G_{14}=0$	438
$(a_{15})^{(1)}G_{14}-\left[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14})\right]G_{15}=0$	439
$(b_{13})^{(1)}T_{14}-[(b_{13}^{'})^{(1)}-(b_{13}^{''})^{(1)}(G)\,]T_{13}=0$	440
$(b_{14})^{(1)}T_{13}-[(b_{14}^{'})^{(1)}-(b_{14}^{''})^{(1)}(G)\,]T_{14}=0$	441
$(b_{15})^{(1)}T_{14}-[(b_{15}^{'})^{(1)}-(b_{15}^{''})^{(1)}(G)\,]T_{15}=0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17}-\left[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17})\right]G_{16}=0$	443
$(a_{17})^{(2)}G_{16}-\left[(a_{17}^{'})^{(2)}+(a_{17}^{''})^{(2)}(T_{17})\right]G_{17}=0$	444
$(a_{18})^{(2)}G_{17}-\left[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17})\right]G_{18}=0$	445
$(b_{16})^{(2)}T_{17}-[(b_{16}^{'})^{(2)}-(b_{16}^{''})^{(2)}(G_{19})\,]T_{16}=0$	446
$(b_{17})^{(2)}T_{16}-[(b_{17}^{'})^{(2)}-(b_{17}^{''})^{(2)}(G_{19})\,]T_{17}=0$	447
$(b_{18})^{(2)}T_{17}-[(b_{18}^{'})^{(2)}-(b_{18}^{''})^{(2)}(G_{19})\,]T_{18}=0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21}-\left[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21})\right]G_{20}=0$	449
$(a_{21})^{(3)}G_{20}-\left[(a_{21}^{'})^{(3)}+(a_{21}^{''})^{(3)}(T_{21})\right]G_{21}=0$	450
$(a_{22})^{(3)}G_{21}-\left[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21})\right]G_{22}=0$	451
$(b_{20})^{(3)}T_{21}-[(b_{20}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23})\,]T_{20}=0$	452
$(b_{21})^{(3)}T_{20}-[(b_{21}^{'})^{(3)}-(b_{21}^{''})^{(3)}(G_{23})\,]T_{21}=0$	453
$(b_{22})^{(3)}T_{21}-[(b_{22}^{'})^{(3)}-(b_{22}^{''})^{(3)}(G_{23})\,]T_{22}=0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25}-\left[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25})\right]G_{24}=0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) +$ $(a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (j) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) +$	492 A

$(a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T_{14}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^* for which $f(T_{14}^*) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^*)]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^*)]}$	493
Definition and uniqueness of T_{17}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^* for which $f(T_{17}^*) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^*)]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^*)]}$	495
Definition and uniqueness of T_{21}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^* for which $f(T_{21}^*) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^*)]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^*)]}$	496
Definition and uniqueness of T_{25}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^* for which $f(T_{25}^*) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^*)]}$	497
Definition and uniqueness of T_{29}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^* for which $f(T_{29}^*) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^*)]}$	498
Definition and uniqueness of T_{33}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^* for which $f(T_{33}^*) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	
Definition and uniqueness of T_{37}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$	500
Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)] + (b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
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Where in $(G_{19})(G_{16},G_{17},G_{18}),G_{16},G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	504
By the same argument, the equations admit solutions G_{20},G_{21} if $\varphi(G_{23})=(b_{20}')^{(3)}(b_{21}')^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23})+(b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right]+(b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20},G_{21},G_{22}),G_{20},G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24},G_{25} if $\varphi(G_{27})=(b_{24}')^{(4)}(b_{25}')^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27})+(b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right]+(b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24},G_{25},G_{26}),G_{24},G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28},G_{29} if $\varphi(G_{31})=(b_{28}')^{(5)}(b_{29}')^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31})+(b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right]+(b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28},G_{29},G_{30}),G_{28},G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32},G_{33} if $\varphi(G_{35})=(b_{32}')^{(6)}(b_{33}')^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35})+(b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right]+(b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32},G_{33},G_{34}),G_{32},G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*})=0$	508
By the same argument, the equations admit solutions G_{36},G_{37} if $\varphi(G_{39})=(b_{36}')^{(7)}(b_{37}')^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39})+(b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right]+(b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36},G_{37},G_{38}),G_{36},G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*})=0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*) = 0$	510
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Finally we obtain the unique solution G^*_{14} given by $\varphi(G^*) = 0$, T^*_{14} given by $f(T^*_{14}) = 0$ and $G^*_{13} = \frac{(a_{13})^{(1)}G^*_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G^*_{15} = \frac{(a_{15})^{(1)}G^*_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$ $T^*_{13} = \frac{(b_{13})^{(1)}T^*_{14}}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T^*_{15} = \frac{(b_{15})^{(1)}T^*_{14}}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G^*_{17} given by $\varphi((G_{19})^*) = 0$, T^*_{17} given by $f(T^*_{17}) = 0$ and	512
$G^*_{16} = \frac{(a_{16})^{(2)}G^*_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G^*_{18} = \frac{(a_{18})^{(2)}G^*_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	513
$T^*_{16} = \frac{(b_{16})^{(2)}T^*_{17}}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T^*_{18} = \frac{(b_{18})^{(2)}T^*_{17}}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G^*_{21} given by $\varphi((G_{23})^*) = 0$, T^*_{21} given by $f(T^*_{21}) = 0$ and $G^*_{20} = \frac{(a_{20})^{(3)}G^*_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G^*_{22} = \frac{(a_{22})^{(3)}G^*_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$ $T^*_{20} = \frac{(b_{20})^{(3)}T^*_{21}}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T^*_{22} = \frac{(b_{22})^{(3)}T^*_{21}}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations

Finally we obtain the unique solution 516

G_{25}^{*} given by $\varphi(G_{27}) = 0$, T_{25}^{*} given by $f(T_{25}^{*}) = 0$ and

$$G_{24}^{*} = \frac{(a_{24})^{(4)} G_{25}^{*}}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^{*})]} \quad , \quad G_{26}^{*} = \frac{(a_{26})^{(4)} G_{25}^{*}}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^{*})]}$$

$$T_{24}^{*} = \frac{(b_{24})^{(4)} T_{25}^{*}}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^{*})]} \quad , \quad T_{26}^{*} = \frac{(b_{26})^{(4)} T_{25}^{*}}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^{*})]} \quad 517$$

Obviously, these values represent an equilibrium solution of global equations

Finally we obtain the unique solution 518

G_{29}^{*} given by $\varphi((G_{31})^{*}) = 0$, T_{29}^{*} given by $f(T_{29}^{*}) = 0$ and

$$G_{28}^{*} = \frac{(a_{28})^{(5)} G_{29}^{*}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]} \quad , \quad G_{30}^{*} = \frac{(a_{30})^{(5)} G_{29}^{*}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$$

$$T_{28}^{*} = \frac{(b_{28})^{(5)} T_{29}^{*}}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^{*})]} \quad , \quad T_{30}^{*} = \frac{(b_{30})^{(5)} T_{29}^{*}}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^{*})]} \quad 519$$

Obviously, these values represent an equilibrium solution of global equations

Finally we obtain the unique solution 520

G_{33}^{*} given by $\varphi((G_{35})^{*}) = 0$, T_{33}^{*} given by $f(T_{33}^{*}) = 0$ and

$$G_{32}^{*} = \frac{(a_{32})^{(6)} G_{33}^{*}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]} \quad , \quad G_{34}^{*} = \frac{(a_{34})^{(6)} G_{33}^{*}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$$

$$T_{32}^{*} = \frac{(b_{32})^{(6)} T_{33}^{*}}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^{*})]} \quad , \quad T_{34}^{*} = \frac{(b_{34})^{(6)} T_{33}^{*}}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^{*})]} \quad 521$$

Obviously, these values represent an equilibrium solution of global equations

Finally we obtain the unique solution 522

G_{37}^{*} given by $\varphi((G_{39})^{*}) = 0$, T_{37}^{*} given by $f(T_{37}^{*}) = 0$ and

$$G_{36}^{*} = \frac{(a_{36})^{(7)} G_{37}^{*}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]} \quad , \quad G_{38}^{*} = \frac{(a_{38})^{(7)} G_{37}^{*}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$$

$$T_{36}^{*} = \frac{(b_{36})^{(7)} T_{37}^{*}}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^{*})]} \quad , \quad T_{38}^{*} = \frac{(b_{38})^{(7)} T_{37}^{*}}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^{*})]}$$

Finally we obtain the unique solution 523

G_{41}^{*} given by $\varphi((G_{43})^{*}) = 0$, T_{41}^{*} given by $f(T_{41}^{*}) = 0$ and

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}')^{(8)} - (b_{40}'')^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}')^{(8)} - (b_{42}'')^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote <u>**Definition of**</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial(a_{17}'')^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial(b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}')^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}')^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}')^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}')^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}')^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(3)}$ *and* $(b_i'')^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{21}'')^{(3)}}{\partial \mathbb{T}_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial(b_i'')^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}')^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}')^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}')^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial(b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}\ ) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial(b_i^{''})^{(5)}}{\partial G_j}(\ (G_{31})^{*}\ ) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G^*_{28}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G^*_{29}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G^*_{30}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T^*_{28}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T^*_{29}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T^*_{30}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(6)}$ *and* $(b''_i)^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{33})^{(6)}}{\partial T_{33}}(T^*_{33}) = (q_{33})^{(6)} \quad , \frac{\partial (b''_i)^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G^*_{32}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G^*_{33}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G^*_{34}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T^*_{32}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T^*_{33}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T^*_{34}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ *and* $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i^{''})^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G^*_{42}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T^*_{40}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T^*_{41}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T^*_{42}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(9)}$ *and* $(b''_i)^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G^*_i + \mathbb{G}_i \quad , T_i = T^*_i + \mathbb{T}_i$ $\frac{\partial (a''_{45})^{(9)}}{\partial T_{45}}(T^*_{45}) = (q_{45})^{(9)} \quad , \frac{\partial (b''_i)^{(9)}}{\partial G_j}\left((G_{47})^*\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a'_{44})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G^*_{44}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a'_{45})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G^*_{45}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a'_{46})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G^*_{46}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b'_{44})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T^*_{44}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b'_{45})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T^*_{45}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b'_{46})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T^*_{46}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b'_{15})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a'_{15})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G^*_{14} + (a_{14})^{(1)}(q_{13})^{(1)}G^*_{13}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T^*_{14} + (b_{14})^{(1)}s_{(13),(14)}T^*_{14}\right)$	

$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$

$+\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$

+

$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

+

$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$ +	
$\left((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$\left((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$	

$+\Big(\big((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)}\big)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\Big)$

$\Big(\big((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\big)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\Big)$

$\Big(\big((\lambda)^{(5)}\big)^{2}+\big((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\big)(\lambda)^{(5)}\Big)$

$\Big(\big((\lambda)^{(5)}\big)^{2}+\big((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\big)(\lambda)^{(5)}\Big)$

$+\Big(\big((\lambda)^{(5)}\big)^{2}+\big((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\big)(\lambda)^{(5)}\Big)(q_{30})^{(5)}G_{30}$

$+\big((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\big)\big((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\big)$

$\Big(\big((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\big)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\Big)\}=0$

+

$\big((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)}\big)\{\big((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)}\big)$

$\Big[\Big(\big((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\big)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\Big)\Big]$

$\Big(\big((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\big)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\Big)$

$+\Big(\big((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)}\big)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\Big)$

$\Big(\big((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\big)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\Big)$

$\Big(\big((\lambda)^{(6)}\big)^{2}+\big((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\big)(\lambda)^{(6)}\Big)$

$\Big(\big((\lambda)^{(6)}\big)^{2}+\big((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\big)(\lambda)^{(6)}\Big)$

$+\Big(\big((\lambda)^{(6)}\big)^{2}+\big((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\big)(\lambda)^{(6)}\Big)(q_{34})^{(6)}G_{34}$

$+\big((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\big)\big((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\big)$

$\Big(\big((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\big)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\Big)\}=0$

+

$\big((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)}\big)\{\big((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)}\big)$

$\Big[\Big(\big((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\big)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\Big)\Big]$

$\Big(\big((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\big)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\Big)$

$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$

$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)$

$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)$

$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$$\left(\left((\lambda)^{(9)}+(b'_{44})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T^*_{45}+(b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$$

$$+\left(\left((\lambda)^{(9)}+(a'_{45})^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G^*_{44}+(a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$$

$$\left(\left((\lambda)^{(9)}+(b'_{44})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T^*_{45}+(b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2+\left((a'_{44})^{(9)}+(a'_{45})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2+\left((b'_{44})^{(9)}+(b'_{45})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^2+\left((a'_{44})^{(9)}+(a'_{45})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a'_{44})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$$

$$\left(\left((\lambda)^{(9)}+(b'_{44})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T^*_{45}+(b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION ELEVEN

Fluid/Gravity Correspondence And The CFM Brane-World Solutions

INTRODUCTION—VARIABLES USED

Photon and dilepton production in supersymmetric Yang-Mills plasma Simon Caron-Huot, Pavel Kovtun, Guy Moore, Andrei Starinets, Laurence G. Yaffe

(1) Comparison of the photo-emission spectra for (e) N=4 plasma at weak coupling, N=4 plasma at (eb) strong coupling, and QCD at (eb) weak coupling reveals several systematic trends which they discuss.
(2) They also evaluate the electric conductivity of N=4 plasma in (eb) the strong coupling limit, and to leading-log order at (eb) weak coupling.
(3) Current-current spectral functions in the strongly coupled theory exhibit (eb) hydrodynamic peaks at small frequency, but otherwise show no (e) structure which could be (=) interpreted as well-defined thermal resonances in (eb) the high-temperature phase Subjects: High Energy Physics - Theory (hep-th); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) Journal reference: JHEP0612:015,2006 DOI: 10.1088/1126-6708/2006/12/015 Cite as:

arXiv:hep-th/0607237 (or arXiv:hep-th/0607237v2 for this version)

Fluid/gravity correspondence and the CFM brane-world solutions Roberto Casadio, Rogerio T. Cavalcanti, Roldao da Rocha

(4) Authors consider the lower bound for (e) the shear viscosity-to-entropy ratio obtained from (e) the fluid/gravity correspondence in order to constrain (e) the post-Newtonian parameter of brane-world metrics.

(5) In particular, authors analyse the Casadio-Fabbri-Mazzacurati (CFM) effective solutions for (e) the gravity side of the correspondence and argue that including higher order terms in (eb) the hydrodynamic expansion can lead to (eb) a full agreement with (=) the experimental bounds for the Eddington-Robertson-Schiff post-Newtonian parameter of the CFM metrics.

(6) This lends further support to (eb) the physical relevance of (e) the viscosity-to-entropy ratio lower bound and (e&eb) fluid/gravity correspondence overall. Subjects: High Energy Physics - Theory (hep-th); General Relativity and Quantum Cosmology (gr-qc) Cite as: arXiv: 1601.03222 [hep-th] (or arXiv: 1601.03222v1 [hep-th] for this version)

NOTATION

Module One

They also evaluate the electric conductivity of N=4 plasma in (eb) the strong coupling limit, and to leading-log order at (eb) weak coupling

G_{13} : Category one of electric conductivity of N=4 plasma

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of strong coupling limit, and to leading-log order at (eb) weak coupling

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

They also evaluate the electric conductivity of N=4 plasma in the strong coupling limit, and to leading-log order at (eb) weak coupling

G_{16} : Category one of electric conductivity of N=4 plasma; **weak coupling**

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of **weak coupling** ;electric conductivity of N=4 plasma

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

Comparison of the photo-emission spectra for (e) N=4 plasma at weak coupling, N=4 plasma at (eb) strong coupling, and QCD at (eb) weak coupling reveals several systematic trends which they discuss

G_{20} : Category one of N=4 plasma at weak coupling, N=4 plasma at (eb) strong coupling, and QCD at (eb) weak coupling reveals several systematic trends which they discuss

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of photo-emission spectra

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

Comparison of the photo-emission spectra for N=4 plasma at weak coupling, N=4 plasma at (eb) strong coupling, and QCD at (eb) weak coupling reveals several systematic trends which they discuss

G_{24} : Category one of **photo-emission spectra for N=4 plasma at weak coupling;** N=4 plasma at strong coupling, and QCD at weak coupling

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of N=4 plasma at strong coupling, and QCD at weak coupling **;photo-emission spectra for N=4 plasma at weak coupling**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

Current-current spectral functions in the strongly coupled theory exhibit (eb) hydrodynamic peaks at small frequency, but otherwise show no (e) structure which could be (=) interpreted as well-defined thermal resonances in (eb) the high-temperature phase

Subjects: High Energy Physics - Theory (hep-th); High Energy Physics - Phenomenology (hep-ph); Nuclear Theory (nucl-th) Journal reference: JHEP0612:015,2006 DOI: 10.1088/1126-6708/2006/12/015 Cite as: arXiv:hep-th/0607237 (or arXiv:hep-th/0607237v2 for this version)

G_{28} : Category one of Current-current spectral functions in the strongly coupled theory

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of hydrodynamic peaks at small frequency, but otherwise show no (e) structure which could be (=) interpreted as well-defined thermal resonances in (eb) the high-temperature phase

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

Current-current spectral functions in the strongly coupled theory exhibit hydrodynamic peaks at small frequency, but otherwise show no (e) structure which could be (=) interpreted as well-defined thermal resonances in (eb) the high-temperature phase

G_{32} : Category one of structure which could be (=) interpreted as well-defined thermal resonances in (eb) the high-temperature phase

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of Current-current spectral functions in the strongly coupled theory exhibit hydrodynamic peaks at small frequency, but otherwise show

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

Current-current spectral functions in the strongly coupled theory exhibit hydrodynamic peaks at small frequency, but otherwise show no structure which could be (=) interpreted as well-defined thermal resonances in (eb) the high-temperature phase

G_{36} : Category one of Current-current spectral functions in the strongly coupled theory exhibit hydrodynamic peaks at small frequency, but otherwise show no structure

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of well-defined thermal resonances in the high-temperature phase

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

Authors consider the lower bound for (e) the shear viscosity-to-entropy ratio obtained from (e) the fluid/gravity correspondence in order to constrain (e) the post-Newtonian parameter of brane-world metrics

G_{40} : Category one of **lower bound;** shear viscosity-to-entropy ratio obtained from (e) the fluid/gravity correspondence in order to constrain (e) the post-Newtonian parameter of brane-world metrics

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of shear viscosity-to-entropy ratio obtained from (e) the fluid/gravity correspondence in order to constrain (e) the post-Newtonian parameter of brane-world metrics; **lower bound**

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

Authors consider the lower bound for the shear viscosity-to-entropy ratio obtained from (e) the fluid/gravity correspondence in order to constrain (e) the post-Newtonian parameter of brane-world metrics

G_{44} : Category one of fluid/gravity correspondence in order to constrain (e) the post-Newtonian parameter of brane-world metrics

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of lower bound for the shear viscosity-to-entropy ratio

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	

Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}')^{(1)} - (b_{14}'')^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}'')^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}'')^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}')^{(2)} - (b_{16}'')^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}')^{(2)} - (b_{17}'')^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}')^{(2)} - (b_{18}'')^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}'')^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}'')^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}'')^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}'')^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25},t)\right]G_{24}$	19

$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}')^{(4)} - (b_{26}'')^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}'')^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}')^{(5)} - (b_{28}'')^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}')^{(5)} - (b_{29}'')^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}')^{(5)} - (b_{30}'')^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}'')^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}'')^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}')^{(6)} - (b_{32}'')^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}')^{(6)} - (b_{33}'')^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}')^{(6)} - (b_{34}'')^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}'')^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b_{36}')^{(7)} - (b_{36}'')^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b_{37}')^{(7)} - (b_{37}'')^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*

$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}), t\right)\right] T_{38}$	42
$+(a_{36}^{''})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}, t)\right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}, t)\right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}, t)\right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}, t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}, t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}, t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left((G_{47}), t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left((G_{47}), t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left((G_{47}), t\right)\right] T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}\left((G_{47}), t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14}, t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17}, t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37}, t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41}, t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a_{14}^{'})^{(1)} \boxed{+(a_{14}^{''})^{(1)}(T_{14}, t)} \boxed{+(a_{17}^{''})^{(2,2,)}(T_{17}, t)} \boxed{+(a_{21}^{''})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a_{37}^{''})^{(7,7)}(T_{37}, t)} \boxed{+(a_{41}^{''})^{(8,8)}(T_{41}, t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a_{15}^{'})^{(1)} \boxed{+(a_{15}^{''})^{(1)}(T_{14}, t)} \boxed{+(a_{18}^{''})^{(2,2,)}(T_{17}, t)} \boxed{+(a_{22}^{''})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a_{38}^{''})^{(7,7)}(T_{37}, t)} \boxed{+(a_{42}^{''})^{(8,8)}(T_{41}, t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix}\right] G_{15}$	57
Where $\boxed{(a_{13}^{''})^{(1)}(T_{14}, t)}$, $\boxed{(a_{14}^{''})^{(1)}(T_{14}, t)}$, $\boxed{(a_{15}^{''})^{(1)}(T_{14}, t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17}, t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,)}(T_{21}, t)}$, $\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21}, t)}$, $\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21}, t)}$ are third augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{24}'')^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}'')^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a_{40}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}'')^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b_{13}')^{(1)}\boxed{-(b_{13}'')^{(1)}(G,t)} \; \boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)} \; \boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)} \; \boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)} \; \boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)} \; \boxed{-(b_{40}'')^{(8,8)}(G_{43},t)} \; \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \qquad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b_{14}')^{(1)}\boxed{-(b_{14}'')^{(1)}(G,t)} \; \boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)} \; \boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)} \; \boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)} \; \boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)} \; \boxed{-(b_{41}'')^{(8,8)}(G_{43},t)} \; \boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14} \qquad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b_{15}')^{(1)}\boxed{-(b_{15}'')^{(1)}(G,t)} \; \boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)} \; \boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)} \; \boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)} \; \boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)} \; \boxed{-(b_{42}'')^{(8,8)}(G_{43},t)} \; \boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15} \qquad 60$$

Where $\boxed{-(b_{13}'')^{(1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{40}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{41}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{42}'')^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$	65

$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{20}$	70
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{21}$	71
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{22}$	72
$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3* $\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\begin{bmatrix}(a'_{24})^{(4)}\boxed{+(a''_{24})^{(4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{24}$	73
$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\begin{bmatrix}(a'_{25})^{(4)}\boxed{+(a''_{25})^{(4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{25}$	74
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\begin{bmatrix}(a'_{26})^{(4)}\boxed{+(a''_{26})^{(4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{26}$	75
$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3 $\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\begin{bmatrix}(b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{24}$	76
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\begin{bmatrix}(b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{25}$	77

$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3	

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{28}$	*82*
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{29}$	*83*
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{30}$	*84*
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3	

$\boxed{-(b_{46}'')^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a_{32}')^{(6)} \boxed{+(a_{32}'')^{(6)}(T_{33},t)} \boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$	85
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a_{33}')^{(6)} \boxed{+(a_{33}'')^{(6)}(T_{33},t)} \boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$	86
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a_{34}')^{(6)} \boxed{+(a_{34}'')^{(6)}(T_{33},t)} \boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$	87
$\boxed{+(a_{32}'')^{(6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a_{16}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a_{20}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b_{32}')^{(6)} \boxed{-(b_{32}'')^{(6)}(G_{35},t)} \boxed{-(b_{28}'')^{(5,5,5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32}$	88

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$$	89
$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$$	90

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$	91
$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$	92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \qquad (93)$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$

are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \qquad (94)$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b_{44}')^{(9)}\boxed{-(b_{44}'')^{(9)}(G_{47},t)} & \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b_{45}')^{(9)}\boxed{-(b_{45}'')^{(9)}(G_{47},t)} & \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}')^{(9)}\boxed{-(b_{46}'')^{(9)}(G_{47},t)} & \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b_{44}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i')^{(1)}, (a_i'')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (b_i'')^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i'')^{(1)}, (b_i'')^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\|(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14} - T_{14}'\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G - G'\|\|e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \ , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
<u>**Definition of**</u> $(p_i)^{(2)}, \ (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17}, t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19}, t) \leq \ (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2 \to \infty} (a_i'')^{(2)}(T_{17}, t) = (p_i)^{(2)}$	104
$\lim_{G \to \infty} (b_i'')^{(2)}((G_{19}), t) = \ (r_i)^{(2)}$	105
<u>**Definition of**</u> $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}}$ are positive constants and $\boxed{i = 16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(2)}(T_{17}', t) - (a_i'')^{(2)}(T_{17}, t)\rvert \leq (\hat{k}_{16})^{(2)} \lvert T_{17} - T_{17}' \rvert e^{-(\hat{M}_{16})^{(2)} t}$	107
$\lvert(b_i'')^{(2)}((G_{19})', t) - (b_i'')^{(2)}((G_{19}), t)\rvert < (\hat{k}_{16})^{(2)} \lvert\lvert (G_{19}) - (G_{19})' \rvert\rvert e^{-(\hat{M}_{16})^{(2)} t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}', t)$ and$(a_i'')^{(2)}(T_{17}, t)$. (T_{17}', t) and (T_{17}, t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} \ , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
<u>**Definition of**</u> $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and \ (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16{,}17{,}18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i^{'})^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i^{'})^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20{,}21{,}22$ The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty} (a_i^{''})^{(3)}\,(T_{21}, t) = (p_i)^{(3)}$ $\mathrm{lim}_{\mathrm{G} \to \infty} (b_i^{''})^{(3)}\,(G_{23}, t) = \ (r_i)^{(3)}$ **<u>Definition of</u>** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20{,}21{,}22}$	113
They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(3)}(T_{21}^{'}, t) - (a_i^{''})^{(3)}(T_{21}, t) \rvert \leq (\hat{k}_{20})^{(3)} \lvert T_{21} - T_{21}^{'} \rvert e^{-(\hat{M}_{20})^{(3)} t}$ $\lvert (b_i^{''})^{(3)}(G_{23}{}', t) - (b_i^{''})^{(3)}(G_{23}, t) \rvert < (\hat{k}_{20})^{(3)} \lvert\lvert G_{23} - G_{23}{}' \rvert\rvert e^{-(\hat{M}_{20})^{(3)} t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and $(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} \ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
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They satisfy Lipschitz condition: $\|(a_i^{''})^{(4)}(T_{25}^{'}, t) - (a_i^{''})^{(4)}(T_{25}, t)\| \leq (\hat{k}_{24})^{(4)}\|T_{25} - T_{25}^{'}\|e^{-(\hat{M}_{24})^{(4)}t}$ $\|(b_i^{''})^{(4)}((G_{27})^{'}, t) - (b_i^{''})^{(4)}((G_{27}), t)\| < (\hat{k}_{24})^{(4)}\|\|(G_{27}) - (G_{27})^{'}\|\|e^{-(\hat{M}_{24})^{(4)}t}$	119
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Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}, \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i')^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)} (\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i')^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)} (\hat{k}_{24})^{(4)}] < 1$	121
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$(a_i)^{(5)}, (a_i')^{(5)}, (a_i'')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (b_i'')^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i'')^{(5)}, (b_i'')^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29}, t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}), t) \leq (r_i)^{(5)} \leq (b_i')^{(5)} \leq (\hat{B}_{28})^{(5)}$	122
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Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \le (p_i)^{(6)} \le (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \le (r_i)^{(6)} \le (b_i')^{(6)} \le (\hat{B}_{32})^{(6)}$	127
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They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\rvert \le (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)} t}$ $\lvert(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}\left((G_{35}), t\right)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)} t}$	
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Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants	129

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}, \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
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Where we suppose	
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They satisfy Lipschitz condition: $\lvert (a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t) \rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}' \rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert (b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t) \rvert < (\hat{k}_{36})^{(7)} \lVert (G_{39}) - (G_{39})' \rVert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (MMM) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (NNN) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i, j = 40,41,42$	136
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$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}), t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
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Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\|(a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t)\| \leq (\hat{k}_{40})^{(8)} \|T_{41} - T_{41}'\| e^{-(\hat{M}_{40})^{(8)} t}$	142

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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}',t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)}=1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}<1$	144
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$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i')^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
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$\lim_{T_2\to\infty}(a_i^{''})^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i^{''})^{(9)}(G_{47},t)=\ (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition:	

$$|(a_i'')^{(9)}(T_{45}',t) - (a_i'')^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i'')^{(9)}((G_{47})',t) - (b_i'')^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and$(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)} (\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)} (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t} , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t} , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0), T_i(0)$

$$G_i(t) \leq (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t} , \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t} , \quad T_i(0) = T_i^0 > 0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t) \leq (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t} , \quad G_i(0) = G_i^0 > 0$$

$T_i(t) \leq \ (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36}\right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40}\right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44}\right)^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}')^{(1)} - (b_{13}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}')^{(1)} - (b_{14}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}')^{(1)} - (b_{15}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}')^{(2)} + a_{16}'')^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}')^{(2)} - (b_{16}'')^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}')^{(2)} - (b_{17}'')^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}')^{(2)} - (b_{18}'')^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{\mathrm{T}}_{22}(\mathrm{t}) = \mathrm{T}_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0 \le (\hat{P}_{32})^{(6)}\ ,T_i^0 \le (\hat{Q}_{32})^{(6)},$	
$0 \le G_i(t)-G_i^0 \le (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \le T_i(t)-T_i^0 \le (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t)=G_{32}^0+\int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a'_{32})^{(6)} + a''_{32})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t)=G_{33}^0+\int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t)=G_{34}^0+\int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t)=T_{32}^0+\int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t)=T_{33}^0+\int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{\mathrm{T}}_{34}(\mathrm{t})=\mathrm{T}_{34}^0+\int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0 \le (\hat{P}_{36})^{(7)}\ ,T_i^0 \le (\hat{Q}_{36})^{(7)},$	
$0 \le G_i(t)-G_i^0 \le (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \le T_i(t)-T_i^0 \le (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t)=G_{36}^0+\int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t)=G_{37}^0+\int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t)=G_{38}^0+\int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t)=T_{36}^0+\int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39}(s_{(36)}),s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}')^{(9)} + a_{44}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}')^{(9)} - (b_{44}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}')^{(9)} - (b_{45}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}')^{(9)} - (b_{46}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
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$\frac{(b_i)^{(5)}}{(\mathcal{M}_{28})^{(5)}}\left[((\widehat{Q}_{28})^{(5)}+T_j^0)e^{-\left(\frac{(\widehat{Q}_{28})^{(5)}+T_j^0}{T_j^0}\right)}+(\widehat{Q}_{28})^{(5)}\right]\leq(\widehat{Q}_{28})^{(5)}$	235
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Where $s_{(28)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on it follows

$$\left|(G_{31})^{(1)} - (G_{31})^{(2)}\right| e^{-(\widehat{M}_{28})^{(5)} t} \leq \frac{1}{(\widehat{M}_{28})^{(5)}} \left((a_{28})^{(5)} + (a'_{28})^{(5)} + (\widehat{A}_{28})^{(5)} + (\widehat{P}_{28})^{(5)} (\widehat{k}_{28})^{(5)}\right) d\left(\left((G_{31})^{(1)}, (T_{31})^{(1)}; (G_{31})^{(2)}, (T_{31})^{(2)}\right)\right)$$ 237

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 21: The fact that we supposed $(a''_{28})^{(5)}$ and $(b''_{28})^{(5)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{28})^{(5)} e^{(\widehat{M}_{28})^{(5)} t}$ *and* $(\widehat{Q}_{28})^{(5)} e^{(\widehat{M}_{28})^{(5)} t}$ respectively of $\mathbb{R}_+$. 238

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(5)}$ and $(b''_i)^{(5)}, i = 28,29,30$ depend only on T_{29} and respectively on (G_{31})(*and not on t*) and hypothesis can replaced by a usual Lipschitz condition.

Remark 22: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ 239

it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(5)} - (a''_i)^{(5)}(T_{29}(s_{(28)}), s_{(28)})\} ds_{(28)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{\left(-(b'_i)^{(5)} t\right)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{28})^{(5)}\right)_1, \left((\widehat{M}_{28})^{(5)}\right)_2$ *and* $\left((\widehat{M}_{28})^{(5)}\right)_3$: 240

Remark 23: if G_{28} is bounded, the same property have also G_{29} *and* G_{30} . indeed if

$G_{28} < (\widehat{M}_{28})^{(5)}$ it follows $\frac{dG_{29}}{dt} \leq \left((\widehat{M}_{28})^{(5)}\right)_1 - (a'_{29})^{(5)} G_{29}$ and by integrating

$$G_{29} \leq \left((\widehat{M}_{28})^{(5)}\right)_2 = G_{29}^0 + 2(a_{29})^{(5)} \left((\widehat{M}_{28})^{(5)}\right)_1 / (a'_{29})^{(5)}$$

In the same way , one can obtain

$$G_{30} \leq \left((\widehat{M}_{28})^{(5)}\right)_3 = G_{30}^0 + 2(a_{30})^{(5)} \left((\widehat{M}_{28})^{(5)}\right)_2 / (a'_{30})^{(5)}$$

If G_{29} *or* G_{30} is bounded, the same property follows for G_{28} , G_{30} and G_{28} , G_{29} respectively.

Remark 24: If G_{28} *is* bounded, from below, the same property holds for G_{29} *and* G_{30} . The proof is analogous with the preceding one. An analogous property is true if G_{29} is bounded from below. 241

Remark 25: If T_{28} is bounded from below and $\lim_{t\to\infty}((b''_i)^{(5)}((G_{31})(t), t)) = (b'_{29})^{(5)}$ then $T_{29} \to \infty$. 242

Definition of $(m)^{(5)}$ and ε_5 :

Indeed let t_5 be so that for $t > t_5$

$(b_{29})^{(5)} - (b_i'')^{(5)}((G_{31})(t), t) < \varepsilon_5, T_{28}\,(t) > (m)^{(5)}$	
Then $\frac{dT_{29}}{dt} \geq (a_{29})^{(5)}(m)^{(5)} - \varepsilon_5 T_{29}$ which leads to $T_{29} \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{\varepsilon_5}\right)(1 - e^{-\varepsilon_5 t}) + T_{29}^0 e^{-\varepsilon_5 t}$ If we take t such that $e^{-\varepsilon_5 t} = \frac{1}{2}$ it results $T_{29} \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{2}\right), \quad t = log\frac{2}{\varepsilon_5}$ By taking now ε_5 sufficiently small one sees that T_{29} is unbounded. The same property holds for T_{30} if $\lim_{t\to\infty}(b_{30}'')^{(5)}\left((G_{31})(t), t\right) = (b_{30}')^{(5)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations Analogous inequalities hold also for $G_{33}, G_{34}, T_{32}, T_{33}, T_{34}$	243
It is now sufficient to take $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}, \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$ and to choose $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ large to have	244
$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[(\hat{P}_{32})^{(6)} + ((\hat{P}_{32})^{(6)} + G_j^0)e^{-\left(\frac{(\hat{P}_{32})^{(6)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{32})^{(6)}$	245
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The operator $\mathcal{A}^{(6)}$ is a contraction with respect to the metric $d\left(((G_{35})^{(1)}, (T_{35})^{(1)}), ((G_{35})^{(2)}, (T_{35})^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{32})^{(6)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{32})^{(6)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{35})}, \widetilde{(T_{35})}$: $\left(\widetilde{(G_{35})}, \widetilde{(T_{35})}\right) = \mathcal{A}^{(6)}((G_{35}), (T_{35}))$ It results $\lvert \tilde{G}_{32}^{(1)} - \tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{32})^{(6)} \lvert G_{33}^{(1)} - G_{33}^{(2)}\rvert e^{-(\hat{M}_{32})^{(6)}s_{(32)}} e^{(\hat{M}_{32})^{(6)}s_{(32)}}\, ds_{(32)} +$ $\int_0^t \{(a_{32}')^{(6)} \lvert G_{32}^{(1)} - G_{32}^{(2)}\rvert e^{-(\hat{M}_{32})^{(6)}s_{(32)}} e^{-(\hat{M}_{32})^{(6)}s_{(32)}} +$ $(a_{32}'')^{(6)}(T_{33}^{(1)}, s_{(32)}) \lvert G_{32}^{(1)} - G_{32}^{(2)}\rvert e^{-(\hat{M}_{32})^{(6)}s_{(32)}} e^{(\hat{M}_{32})^{(6)}s_{(32)}} +$	247

$G_{32}^{(2)}\lvert(a_{32}'')^{(6)}\big(T_{33}^{(1)},s_{(32)}\big)-(a_{32}'')^{(6)}\big(T_{33}^{(2)},s_{(32)}\big)\rvert\ e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$ Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	
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Remark 29: If G_{32} *is* bounded, from below, the same property holds for G_{33} *and* G_{34} . The proof is analogous with the preceding one. An analogous property is true if G_{33} is bounded from below.	252
Remark 30: If T_{32} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(6)}\,((G_{35})(t),t))=(b_{33}')^{(6)}$ then $T_{33}\to\infty$. **Definition of** $(m)^{(6)}$ and ε_6 :	253

Indeed let t_6 be so that for $t > t_6$ $(b_{33})^{(6)} - (b_i'')^{(6)}\big((G_{35})(t), t\big) < \varepsilon_6, T_{32}\,(t) > (m)^{(6)}$	
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If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.

Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below. 277

Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. 278

Definition of $(m)^{(8)}$ and ε_8 :

Indeed let t_8 be so that for $t > t_8$

$(b_{41})^{(8)} - (b_i'')^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}\,(t) > (m)^{(8)}$

Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to 279

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\big((G_{43})(t),t(t),t\big) = (b_{42}')^{(8)}$

It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + \big((\hat{P}_{44})^{(9)} + G_j^0\big)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\big((\hat{Q}_{44})^{(9)} + T_j^0\big)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})} : \big(\widetilde{(G_{47})}, \widetilde{(T_{47})}\big) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_{i}^{(2)}\right| \le \int_0^t (a_{44})^{(9)} \left|G_{45}^{(1)} - G_{45}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} + \int_0^t \{(a_{44}')^{(9)} \left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} + (a_{44}'')^{(9)} \left(T_{45}^{(1)}, s_{(44)}\right) \left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} + G_{44}^{(2)} \left|(a_{44}'')^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a_{44}'')^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)\right| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}}\} ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} t} \le \frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)}\right) d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

<u>**Remark 41:**</u> The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

<u>**Remark 42:**</u> There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \ge G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \ge 0$$

$$T_i(t) \ge T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

<u>**Definition of**</u> $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

<u>**Remark 43:**</u> if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \le \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$$G_{45} \le \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$$

In the same way , one can obtain

$$G_{46} \le \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

<u>**Remark 44:**</u> If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t),t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t),t) = (b_{46}')^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
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Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if \ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$	283

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}^{'})^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a_{15}^{'})^{(1)}t}] + G_{15}^0 e^{-(a_{15}^{'})^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}^{'})^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}^{'})^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}^{'})^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}^{'})^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}^{'})^{(1)}$ $(R_2)^{(1)} = (b_{15}^{'})^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\big((G_{19}), t\big) - (b_{17}^{''})^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\big(u^{(2)}\big)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},$ ***if*** $(\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}$, ***if*** $(\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},$ ***if*** $(\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},$ ***if*** $(u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}$, ***if*** $(u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},$ ***if*** $(\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^{0} e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^{0} e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^{0} e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_2)^{(2)}((S_1)^{(2)}-(a'_{18})^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a'_{18})^{(2)}t}\right] + G_{18}^{0} e^{-(a'_{18})^{(2)}t}\right)$	312
$\boxed{T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^{0}}{(\mu_1)^{(2)}((R_1)^{(2)}-(b'_{18})^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b'_{18})^{(2)}t}\right] + T_{18}^{0} e^{-(b'_{18})^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^{0}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^{0} e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a'_{16})^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b'_{16})^{(2)}$ $(R_2)^{(2)} = (b'_{18})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a'_{20})^{(3)} + (a'_{21})^{(3)} - (a''_{20})^{(3)}(T_{21}, t) + (a''_{21})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b'_{20})^{(3)} + (b'_{21})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) - (b''_{21})^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0$, $(\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0$, $(u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0\,,(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0\,,(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
<u>**Definition of**</u> $(m_1)^{(3)}\,,(m_2)^{(3)}\,,(\mu_1)^{(3)},(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}\,,(m_2)^{(3)}\,,(\mu_1)^{(3)},(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)},(m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)},(m_1)^{(3)} = (\bar{\nu}_1)^{(3)}\,,\boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)},(m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)},(\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)},(\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\,,\boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)},(\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0\, e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \le G_{20}(t) \le G_{20}^0\, e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \le G_{21}(t) \le \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \le G_{22}(t) \le\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \le T_{20}(t) \le T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \le T_{20}(t) \le \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \le T_{22}(t) \le$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ ***if*** $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)},$ ***if*** $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ ***if*** $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ ***if*** $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)},$ ***if*** $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>**Definition of**</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>**Definition of**</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)}, , (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, $\boldsymbol{if}$ $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, $\boldsymbol{if}$ $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}$, $\boldsymbol{if}$ $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, $\boldsymbol{if}$ $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b'_{30})^{(5)}t}\right]+T_{30}^0 e^{-(b'_{30})^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)},(S_2)^{(5)},(R_1)^{(5)},(R_2)^{(5)}$:- Where $(S_1)^{(5)}=(a_{28})^{(5)}(m_2)^{(5)}-(a'_{28})^{(5)}$ $(S_2)^{(5)}=(a_{30})^{(5)}-(p_{30})^{(5)}$ $(R_1)^{(5)}=(b_{28})^{(5)}(\mu_2)^{(5)}-(b'_{28})^{(5)}$ $(R_2)^{(5)}=(b'_{30})^{(5)}-(r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$: $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)}\leq-(a'_{32})^{(6)}+(a'_{33})^{(6)}-(a''_{32})^{(6)}(T_{33},t)+(a''_{33})^{(6)}(T_{33},t)\leq-(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)}\leq-(b'_{32})^{(6)}+(b'_{33})^{(6)}-(b''_{32})^{(6)}\left((G_{35}),t\right)-(b''_{33})^{(6)}\left((G_{35}),t\right)\leq-(\tau_1)^{(6)}$	349
Definition of $(\nu_1)^{(6)},(\nu_2)^{(6)},(u_1)^{(6)},(u_2)^{(6)},\nu^{(6)},u^{(6)}$: By $(\nu_1)^{(6)}>0,(\nu_2)^{(6)}<0$ and respectively $(u_1)^{(6)}>0,(u_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_1)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},$ ***if*** $(\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},$ ***if*** $(\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)},$ and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},$ ***if*** $(\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}] + G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
<u>**Definition of**</u> $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}')^{(7)}$ $(R_2)^{(7)} = (b_{38}')^{(7)} - (r_{38})^{(7)}$	370
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}')^{(8)} + (a_{41}')^{(8)} - (a_{40}'')^{(8)}(T_{41}, t) + (a_{41}'')^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}')^{(8)} + (b_{41}')^{(8)} - (b_{40}'')^{(8)}((G_{43}), t) - (b_{41}'')^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
<u>**Definition of**</u> $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}(\nu^{(8)})^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}\ ,\boldsymbol{if}\ (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)},$ and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ ,\boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}\left((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)}\right)}\left[e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}\left((S_1)^{(8)} - (a_{42}')^{(8)}\right)}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^{0} e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq T_{40}^{0} e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^{0} e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^{0} e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^{0}}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)} t} - e^{-(b'_{42})^{(8)} t}\right] + T_{42}^{0} e^{-(b'_{42})^{(8)} t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^{0}}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)} t}\right] + T_{42}^{0} e^{-(R_2)^{(8)} t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}((G_{47}), t) - (b''_{45})^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$	382
<u>**Definition of**</u> $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
<u>**Definition of**</u> $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ <u>**Definition of**</u> $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},$ ***if*** $(\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, ***if*** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, ***if*** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, ***if*** $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, ***if*** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, ***if*** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\left(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq \frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \right)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$	
Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$	386

And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\quad \boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
<u>Definition of</u> $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **<u>Definition of</u>** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
<u>Particular case :</u> If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

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From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>**Particular case :**</u>

If $(a_{24}^{''})^{(4)} = (a_{25}^{''})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b_{24}^{''})^{(4)} = (b_{25}^{''})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

<u>**Proof**</u> : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}^{'})^{(5)} - (a_{29}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right) - (a_{29}^{''})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

<u>**Definition of**</u> $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}$, $\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}$, $\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\ \nu^{(5)}(t)\leq$

$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$(\nu_1)^{(5)}\leq\ \nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\ \nu^{(5)}(t)\leq(m_1)^{(5)},$ $\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq\ u^{(5)}(t)\leq(\mu_1)^{(5)},$ $\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}^{''})^{(5)} = (a_{29}^{''})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}^{''})^{(5)} = (b_{29}^{''})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}^{'})^{(6)} - (a_{33}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}, t)\right) - (a_{33}^{''})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right) t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right) t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}, \quad \boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}, \quad \boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right) t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right) t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **<u>Definition of</u>** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
<u>Definition of</u> $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **<u>Particular case :</u>** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have	424

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}'')^{(9)} = (a_{45}'')^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}'')^{(9)} = (b_{45}'')^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i'')^{(1)} and\ (b_i'')^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}')^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ \ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
<u>Theorem</u> If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
<u>Theorem</u> : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
<u>Theorem</u> : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
<u>Theorem</u> : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}>0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}-(b_{44}^{'})^{(9)}(r_{45})^{(9)}-(b_{45}^{'})^{(9)}(r_{45})^{(9)}+(r_{44})^{(9)}(r_{45})^{(9)}<0$ *with* $(p_{44})^{(9)},(r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14}-\left[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14})\right]G_{13}=0$	437
$(a_{14})^{(1)}G_{13}-\left[(a_{14}^{'})^{(1)}+(a_{14}^{''})^{(1)}(T_{14})\right]G_{14}=0$	438
$(a_{15})^{(1)}G_{14}-\left[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14})\right]G_{15}=0$	439
$(b_{13})^{(1)}T_{14}-[(b_{13}^{'})^{(1)}-(b_{13}^{''})^{(1)}(G)]T_{13}=0$	440
$(b_{14})^{(1)}T_{13}-[(b_{14}^{'})^{(1)}-(b_{14}^{''})^{(1)}(G)]T_{14}=0$	441
$(b_{15})^{(1)}T_{14}-[(b_{15}^{'})^{(1)}-(b_{15}^{''})^{(1)}(G)]T_{15}=0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17}-\left[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17})\right]G_{16}=0$	443
$(a_{17})^{(2)}G_{16}-\left[(a_{17}^{'})^{(2)}+(a_{17}^{''})^{(2)}(T_{17})\right]G_{17}=0$	444
$(a_{18})^{(2)}G_{17}-\left[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17})\right]G_{18}=0$	445
$(b_{16})^{(2)}T_{17}-[(b_{16}^{'})^{(2)}-(b_{16}^{''})^{(2)}(G_{19})]T_{16}=0$	446
$(b_{17})^{(2)}T_{16}-[(b_{17}^{'})^{(2)}-(b_{17}^{''})^{(2)}(G_{19})]T_{17}=0$	447
$(b_{18})^{(2)}T_{17}-[(b_{18}^{'})^{(2)}-(b_{18}^{''})^{(2)}(G_{19})]T_{18}=0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21}-\left[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21})\right]G_{20}=0$	449
$(a_{21})^{(3)}G_{20}-\left[(a_{21}^{'})^{(3)}+(a_{21}^{''})^{(3)}(T_{21})\right]G_{21}=0$	450
$(a_{22})^{(3)}G_{21}-\left[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21})\right]G_{22}=0$	451
$(b_{20})^{(3)}T_{21}-[(b_{20}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23})]T_{20}=0$	452
$(b_{21})^{(3)}T_{20}-[(b_{21}^{'})^{(3)}-(b_{21}^{''})^{(3)}(G_{23})]T_{21}=0$	453
$(b_{22})^{(3)}T_{21}-[(b_{22}^{'})^{(3)}-(b_{22}^{''})^{(3)}(G_{23})]T_{22}=0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25}-\left[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25})\right]G_{24}=0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\big((G_{27})\big)\,]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\big((G_{27})\big)\,]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\big((G_{27})\big)\,]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (k) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
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Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a'_{32})^{(6)}+(a''_{32})^{(6)}(T^*_{33})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a'_{34})^{(6)}+(a''_{34})^{(6)}(T^*_{33})]}$	
Definition and uniqueness of T^*_{37} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T^*_{37} for which $f(T^*_{37}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a'_{36})^{(7)}+(a''_{36})^{(7)}(T^*_{37})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a'_{38})^{(7)}+(a''_{38})^{(7)}(T^*_{37})]}$	500
Definition and uniqueness of T^*_{41} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T^*_{41} for which $f(T^*_{41}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a'_{40})^{(8)}+(a''_{40})^{(8)}(T^*_{41})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a'_{42})^{(8)}+(a''_{42})^{(8)}(T^*_{41})]}$	501
Definition and uniqueness of T^*_{45} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T^*_{45} for which $f(T^*_{45}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a'_{44})^{(9)}+(a''_{44})^{(9)}(T^*_{45})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a'_{46})^{(9)}+(a''_{46})^{(9)}(T^*_{45})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b'_{13})^{(1)}(b''_{14})^{(1)}(G) + (b'_{14})^{(1)}(b''_{13})^{(1)}(G)\right]+(b''_{13})^{(1)}(G)(b''_{14})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{14} such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b'_{16})^{(2)}(b''_{17})^{(2)}(G_{19}) + (b'_{17})^{(2)}(b''_{16})^{(2)}(G_{19})\right]+(b''_{16})^{(2)}(G_{19})(b''_{17})^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	504
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By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27}) + (b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right] + (b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*}) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31}) + (b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right] + (b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*}) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35}) + (b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right] + (b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*}) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39}) + (b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right] + (b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*}) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b_{40}')^{(8)}(b_{41}'')^{(8)}(G_{43}) + (b_{41}')^{(8)}(b_{40}'')^{(8)}(G_{43})\right] + (b_{40}'')^{(8)}(G_{43})(b_{41}'')^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
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Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b_{13}')^{(1)}-(b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b_{15}')^{(1)}-(b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b_{16}')^{(2)}-(b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b_{18}')^{(2)}-(b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b_{20}')^{(3)}-(b_{20}'')^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b_{22}')^{(3)}-(b_{22}'')^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^*=\frac{(a_{24})^{(4)}G_{25}^*}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^*=\frac{(a_{26})^{(4)}G_{25}^*}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^*=\frac{(b_{24})^{(4)}T_{25}^*}{[(b_{24}')^{(4)}-(b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^*=\frac{(b_{26})^{(4)}T_{25}^*}{[(b_{26}')^{(4)}-(b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*)=0$, T_{29}^* given by $f(T_{29}^*)=0$ and $G_{28}^*=\frac{(a_{28})^{(5)}G_{29}^*}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^*=\frac{(a_{30})^{(5)}G_{29}^*}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^*)]}$	518
$T_{28}^*=\frac{(b_{28})^{(5)}T_{29}^*}{[(b_{28}')^{(5)}-(b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^*=\frac{(b_{30})^{(5)}T_{29}^*}{[(b_{30}')^{(5)}-(b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*)=0$, T_{33}^* given by $f(T_{33}^*)=0$ and $G_{32}^*=\frac{(a_{32})^{(6)}G_{33}^*}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^*=\frac{(a_{34})^{(6)}G_{33}^*}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^*=\frac{(b_{32})^{(6)}T_{33}^*}{[(b_{32}')^{(6)}-(b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^*=\frac{(b_{34})^{(6)}T_{33}^*}{[(b_{34}')^{(6)}-(b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*)=0$, T_{37}^* given by $f(T_{37}^*)=0$ and $G_{36}^*=\frac{(a_{36})^{(7)}G_{37}^*}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^*=\frac{(a_{38})^{(7)}G_{37}^*}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^*=\frac{(b_{36})^{(7)}T_{37}^*}{[(b_{36}')^{(7)}-(b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^*=\frac{(b_{38})^{(7)}T_{37}^*}{[(b_{38}')^{(7)}-(b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*)=0$, T_{41}^* given by $f(T_{41}^*)=0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -((a_{16}^{'})^{(2)} + (p_{16})^{(2)})\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -((a_{17}^{'})^{(2)} + (p_{17})^{(2)})\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -((a_{18}^{'})^{(2)} + (p_{18})^{(2)})\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -((b_{16}^{'})^{(2)} - (r_{16})^{(2)})\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}(s_{(16)(j)}T_{16}^*\mathbb{G}_j)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -((b_{17}^{'})^{(2)} - (r_{17})^{(2)})\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}(s_{(17)(j)}T_{17}^*\mathbb{G}_j)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -((b_{18}^{'})^{(2)} - (r_{18})^{(2)})\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}(s_{(18)(j)}T_{18}^*\mathbb{G}_j)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -((a_{20}^{'})^{(3)} + (p_{20})^{(3)})\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -((a_{21}^{'})^{(3)} + (p_{21})^{(3)})\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -((a_{22}^{'})^{(3)} + (p_{22})^{(3)})\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}(\,(G_{31})^{*}\,) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*}) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}((G_{35})^{*}) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}')^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}')^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}')^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(9)}$ *and* $(b_i'')^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i'')^{(9)}}{\partial G_j}(\,(G_{47})^{*}\,) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}G_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$+\Big(\big((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\big)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\Big)$ $\Big(\big((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\big)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\Big)$ $\Big(\big((\lambda)^{(3)}\big)^{2}+\big((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\big)(\lambda)^{(3)}\Big)$ $\Big(\big((\lambda)^{(3)}\big)^{2}+\big((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\big)(\lambda)^{(3)}\Big)$ $+\Big(\big((\lambda)^{(3)}\big)^{2}+\big((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\big)(\lambda)^{(3)}\Big)(q_{22})^{(3)}G_{22}$ $+\big((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\big)\big((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\big)$ $\Big(\big((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\big)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\Big)\}=0$ +	
$\big((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)}\big)\{\big((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)}\big)$ $\Big[\Big(\big((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\big)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\Big)\Big]$ $\Big(\big((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\big)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\Big)$ $+\Big(\big((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\big)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\Big)$ $\Big(\big((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\big)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\Big)$ $\Big(\big((\lambda)^{(4)}\big)^{2}+\big((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\big)(\lambda)^{(4)}\Big)$ $\Big(\big((\lambda)^{(4)}\big)^{2}+\big((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\big)(\lambda)^{(4)}\Big)$ $+\Big(\big((\lambda)^{(4)}\big)^{2}+\big((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\big)(\lambda)^{(4)}\Big)(q_{26})^{(4)}G_{26}$ $+\big((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\big)\big((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\big)$ $\Big(\big((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\big)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\Big)\}=0$ +	
$\big((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)}\big)\{\big((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)}\big)$ $\Big[\Big(\big((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\big)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\Big)\Big]$ $\Big(\big((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\big)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\Big)$	

$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$ $\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$ $+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$ $+$	
$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$ $\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$ $\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$ $+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$ $\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$ $\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$ $\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$ $+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$ $+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$ $\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$ $+$ $\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$ $\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$ $\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$	

$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$

$+((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)})\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$

$+$

$((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)})\{((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)})$

$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$

$+$

$((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)})\{((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)})$

$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$\left(\left((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^* + (b_{45})^{(9)}s_{(44),(45)}T_{45}^*\right)$

$+\left(\left((\lambda)^{(9)} + (a_{45}')^{(9)} + (p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^* + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^*\right)$

$\left(\left((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^* + (b_{45})^{(9)}s_{(44),(44)}T_{44}^*\right)$

$\left(\left((\lambda)^{(9)}\right)^2 + \left((a_{44}')^{(9)} + (a_{45}')^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)$

$\left(\left((\lambda)^{(9)}\right)^2 + \left((b_{44}')^{(9)} + (b_{45}')^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right) (\lambda)^{(9)}\right)$

$+\left(\left((\lambda)^{(9)}\right)^2 + \left((a_{44}')^{(9)} + (a_{45}')^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+\left((\lambda)^{(9)} + (a_{44}')^{(9)} + (p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^* + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^*\right)$

$\left(\left((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^* + (b_{45})^{(9)}s_{(44),(46)}T_{44}^*\right)\} = 0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION TWELVE

Dense Chern-Simons Matter With Fermions

INTRODUCTION—VARIABLES USED

Hydrodynamics of R-charged black holes Dam T. Son, Andrei O. Starinets

(1) Authors consider hydrodynamics of (e) N=4 supersymmetric SU (N_c) Yang-Mills plasma at (eb) a nonzero density of R-charge.
(2) In the regime of large N_c and (e&eb) large 't Hooft coupling the gravity dual description involves (e&eb) an asymptotically Anti- de Sitter five-dimensional charged black hole solution of Behrnd, Cvetic and Sabra.
(3) They compute the shear viscosity as (=) a function of chemical potentials conjugated to (e&eb) the three U (1) \subset SO (6) _R charges.
(4) The ratio of the shear viscosity to entropy density is independent of (e) the chemical potentials and is (=) equal to 1/4\pi.
(5) For a single charge black hole they also compute the thermal conductivity, and investigate the critical

behavior of (e) the transport coefficients near the boundary of thermodynamic stability. Subjects: High Energy Physics - Theory (hep-th) Journal reference: JHEP 0603:052,2006 DOI: 10.1088/1126-6708/2006/03/052 Report number: INT-PUB 06-02 Cite as: arXiv:hep-th/0601157 (or arXiv:hep-th/0601157v3 for this version)

Dense Chern-Simons Matter with Fermions at Large N Michael Geracie, Mikhail Goykhman, Dam T. Son

(6) In this paper authors investigate properties of Chern-Simons theory coupled to (e&eb) massive fermions in the large N limit.
(7) They demonstrate that at low temperatures the system is (=) in a Fermi liquid state whose features can be systematically compared to (e&eb) the standard phenomenological theory of (e) Landau Fermi liquids.
(8) This includes matching microscopically derived Landau parameters with (e&eb) thermodynamic predictions of Landau Fermi liquid theory.
(9) They also calculate the exact conductivity and (e&eb) viscosity tensors at zero temperature and finite chemical potential.
(10) In particular they point out that the Hall conductivity of (e) an interacting system is not (e) entirely accounted for (e) by the Berry flux through (e&eb) the Fermi sphere.
(11) Furthermore, investigation of the thermodynamics in the non-relativistic limit reveals (eb) novel phenomena at strong coupling.
(12) As the't Hooft coupling approaches 1, the system exhibits (eb) an extended intermediate temperature regime in which the thermodynamics is described by (e) neither the quantum Fermi liquid theory nor the classical ideal gas law.
(13) Instead, it can be interpreted as (=) a weakly coupled quantum Bose gas. Subjects: High Energy Physics - Theory (hep-th); Strongly Correlated Electrons (cond-mat.str-el) Cite as: arXiv:1511.04772 [hep-th] (or arXiv:1511.04772v1 [hep-th] for this version)

NOTATION

Module One

Authors consider hydrodynamics of (e) N=4 supersymmetric SU (N_c) Yang-Mills plasma at (eb) a nonzero density of R-charge

G_{13} : Category one of N=4 supersymmetric SU (N_c) Yang-Mills plasma at (eb) a nonzero density of R-charge

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of hydrodynamics

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Authors consider hydrodynamics of N=4 supersymmetric SU (N_c) Yang-Mills plasma at (eb) a nonzero density of R-charge

G_{16} : Category one of **hydrodynamics of N=4 supersymmetric SU (N_c) Yang-Mills plasma;** nonzero density of R-charge G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of nonzero density of R-charge **;hydrodynamics of N=4 supersymmetric SU (N_c) Yang-Mills plasma** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three In the regime of large N_c and (e&eb) large 't Hooft coupling the gravity dual description involves (e&eb) an asymptotically Anti- de Sitter five-dimensional charged black hole solution of Behrnd, Cvetic and Sabra	
G_{20} : Category one of **large N_c;** large 't Hooft coupling the gravity dual description involves (e&eb) an asymptotically Anti- de Sitter five-dimensional charged black hole solution of Behrnd, Cvetic and Sabra G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of large 't Hooft coupling the gravity dual description involves (e&eb) an asymptotically Anti- de Sitter five-dimensional charged black hole solution of Behrnd, Cvetic and Sabra; **large N_c** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four In the regime of large N_c and large 't Hooft coupling the gravity dual description involves (e&eb) an asymptotically Anti- de Sitter five-dimensional charged black hole solution of Behrnd, Cvetic and Sabra	
G_{24} : Category one of **regime of large N_c and large 't Hooft coupling the gravity dual description;** asymptotically Anti- de Sitter five-dimensional charged black hole solution of Behrnd, Cvetic and Sabra G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of asymptotically Anti- de Sitter five-dimensional charged black hole solution of Behrnd, Cvetic and Sabra **;regime of large N_c and large 't Hooft coupling the gravity dual description** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five They compute the shear viscosity as (=) a function of chemical potentials conjugated to (e&eb) the three U	

(1) \subset SO (6) _R charges	
G_{28} : Category one of shear viscosity G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of function of chemical potentials conjugated to (e&eb) the three U (1) \subset SO (6) _R charges T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six They compute the shear viscosity as a function of chemical potentials conjugated to (e&eb) the three U (1) \subset SO (6) _R charges	
G_{32} : Category one of **shear viscosity as a function of chemical potentials conjugated;** three U (1) \subset SO (6) _R charges G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of three U (1) \subset SO (6) _R charges; **shear viscosity as a function of chemical potentials conjugated** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven The ratio of the shear viscosity to entropy density is independent of (e) the chemical potentials and is (=) equal to 1/4\pi	
G_{36} : Category one of ratio of the shear viscosity to entropy density is independent; **chemical potentials and is equal to 1/4\pi** G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of **chemical potentials and is equal to 1/4\pi;** ratio of the shear viscosity to entropy density is independent T_{37} : Category two of SAS T_{38} : Category three of SAS	

Module eight

For a single charge black hole they also compute the thermal conductivity, and investigate the critical behavior of (e) the transport coefficients near the boundary of thermodynamic stability.

Subjects: High Energy Physics - Theory (hep-th) Journal reference: JHEP 0603:052,2006 DOI: 10.1088/1126-6708/2006/03/052 Report number: INT-PUB 06-02 Cite as: arXiv:hep-th/0601157 (or arXiv:hep-th/0601157v3 for this version)

G_{40} : Category one of **thermal conductivity;** single charge black hole

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of single charge black hole; **thermal conductivity**

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

critical behavior of the transport coefficients near the boundary of thermodynamic stability

G_{44} : Category one of **critical behavior of the transport coefficients;** boundary of thermodynamic stability

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of boundary of thermodynamic stability **;critical behavior of the transport coefficients**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:

$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$:
$(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$
$(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$,
$(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$
$(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$
$(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$
$(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$

are Accentuation coefficients
$(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$
, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$
$(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$,

$(a_{32}^{'})^{(6)}, (a_{33}^{'})^{(6)}, (a_{34}^{'})^{(6)}, (b_{32}^{'})^{(6)}, (b_{33}^{'})^{(6)}, (b_{34}^{'})^{(6)}$ $(a_{36}^{'})^{(7)}, (a_{37}^{'})^{(7)}, (a_{38}^{'})^{(7)}, (b_{36}^{'})^{(7)}, (b_{37}^{'})^{(7)}, (b_{38}^{'})^{(7)},$ $(a_{40}^{'})^{(8)}, (a_{41}^{'})^{(8)}, (a_{42}^{'})^{(8)}, (b_{40}^{'})^{(8)}, (b_{41}^{'})^{(8)}, (b_{42}^{'})^{(8)},$ $(a_{44}^{'})^{(9)}, (a_{45}^{'})^{(9)}, (a_{46}^{'})^{(9)}, (b_{44}^{'})^{(9)}, (b_{45}^{'})^{(9)}, (b_{46}^{'})^{(9)},$ are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	

$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a''_{24})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	*38*

$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}, t) \right] G_{38}$	39
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)} \left((G_{39}), t \right) \right] T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)} \left((G_{39}), t \right) \right] T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)} \left((G_{39}), t \right) \right] T_{38}$	42
$+(a''_{36})^{(7)} (T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)} (T_{41}, t) \right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}, t) \right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)} \left((G_{43}), t \right) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)} \left((G_{43}), t \right) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)} \left((G_{43}), t \right) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)} (T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)} (T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)} (T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)} \left((G_{47}), t \right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)} \left((G_{47}), t \right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)} \left((G_{47}), t \right) \right] T_{46}$	54
$+(a''_{44})^{(9)} (T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)} \left((G_{47}), t \right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13} \quad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14} \quad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15} \quad 60$$

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16}$	*61*
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{17}$	*62*
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{18}$	*63*
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{16}$	*64*

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$$ 65

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$$ 66

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$$ 67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$$ 68

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22}$$ 69

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)}\boxed{-(b''_{20})^{(3)}(G_{23},t)}\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \qquad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)}\boxed{-(b''_{21})^{(3)}(G_{23},t)}\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \qquad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)}\boxed{-(b''_{22})^{(3)}(G_{23},t)}\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \qquad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$
are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$
are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$
are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$
are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$
are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25}$$	77
$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$$	79
$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$$	80
$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation*	

$coefficient\ for\ category\ 1,2\ and\ 3$ $+(a''_{32})^{(6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6)}(T_{33},t)$ $are\ third\ augmentation$ $coefficient\ for\ category\ 1,2\ and\ 3$ $+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)$ are fourth augmentation coefficients for category 1,2, and 3 $+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)$ are fifth augmentation coefficients for category 1,2,and 3 $+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)$ are sixth augmentation coefficients for category 1,2, 3 $+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1,2, 3 $+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)$ are eighth augmentation coefficients for category 1,2, 3 $+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$	84
$where$ $-(b''_{28})^{(5)}(G_{31},t)$, $-(b''_{29})^{(5)}(G_{31},t)$, $-(b''_{30})^{(5)}(G_{31},t)$ $are\ first\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $-(b''_{24})^{(4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,)}(G_{27},t)$ $are\ second\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $-(b''_{32})^{(6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6)}(G_{35},t)$ $are\ third\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $-(b''_{13})^{(1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1)}(G,t)$, $-(b''_{15})^{(1,1,1,1,1,)}(G,t)$ are fourth detrition coefficients for category 1,2, and 3 $-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)$ are fifth detrition coefficients for category 1,2, and 3 $-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1,2, and 3 $-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition	

coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{32}$$ 85

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{33}$$ 86

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{34}$$ 87

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32}$$ 88

$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$	89
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$	90

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	92

$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	*93*
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} =$$

$$(b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$-(b_{28}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3

$-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)$, $-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)$, $-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)$ are sixth detrition coefficients for category 1, 2 and 3

$-(b_{13}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b_{38}'')^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3

$-(b_{44}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b_{45}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b_{46}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45},t) + (a_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ + (a_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ + (a_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45},t) + (a_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ + (a_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ + (a_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{37},t) + (a_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ + (a_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ + (a_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{15}$$

Where $+(a_{44}'')^{(9)}(T_{45},t)$, $+(a_{45}'')^{(9)}(T_{45},t)$, $+(a_{46}'')^{(9)}(T_{37},t)$ are first augmentation coefficients for category 1, 2 and 3

$+(a_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$, $+(a_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$, $+(a_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3

$+(a_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3

$+(a_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3

$+(a_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b_{44}')^{(9)}\boxed{-(b_{44}'')^{(9)}(G_{47},t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b_{45}')^{(9)}\boxed{-(b_{45}'')^{(9)}(G_{47},t)} \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}')^{(9)}\boxed{-(b_{46}'')^{(9)}(G_{47},t)} \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b_{44}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i')^{(1)}, (a_i'')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (b_i'')^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i'')^{(1)}, (b_i'')^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2 \to \infty} (a_i'')^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b_i'')^{(1)} (G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \ , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i^{'})^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i^{'})^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	
Where we suppose	
$(a_i)^{(2)},(a_i^{'})^{(2)},(a_i^{''})^{(2)},(b_i)^{(2)},(b_i^{'})^{(2)},(b_i^{''})^{(2)}>0,\quad i,j=16,17,18$	
The functions $(a_i^{''})^{(2)},(b_i^{''})^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)},\ (r_i)^{(2)}$:	
$(a_i^{''})^{(2)}(T_{17},t)\le(p_i)^{(2)}\le(\hat{A}_{16})^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19},t)\le\ (r_i)^{(2)}\le(b_i^{'})^{(2)}\le(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i^{''})^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i^{''})^{(2)}((G_{19}),t)=\ (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(2)}(T_{17}^{'},t)-(a_i^{''})^{(2)}(T_{17},t)\rvert\le(\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}^{'}\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i^{''})^{(2)}((G_{19})^{'},t)-(b_i^{''})^{(2)}((G_{19}),t)\rvert<(\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})^{'}\rvert\lvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'},t)$ and $(a_i^{''})^{(2)}(T_{17},t)$. $(T_{17}^{'},t)$ and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i^{''})^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)}and\ (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i^{'})^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i^{'})^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, (r_i)^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty}(a_i^{''})^{(3)}(T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty}(b_i^{''})^{(3)}(G_{23}, t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(3)}(T_{21}^{'}, t) - (a_i^{''})^{(3)}(T_{21}, t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}^{'}\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i^{''})^{(3)}(G_{23}{'}, t) - (b_i^{''})^{(3)}(G_{23}, t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}{'}\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and $(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}} [(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}} [(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded. __Definition of__ $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25}, t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}), t) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2 \to \infty} (a_i'')^{(4)} (T_{25}, t) = (p_i)^{(4)}$ $\lim_{G \to \infty} (b_i'')^{(4)} ((G_{27}), t) = (r_i)^{(4)}$ __Definition of__ $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	118
They satisfy Lipschitz condition: $\|(a_i'')^{(4)}(T_{25}', t) - (a_i'')^{(4)}(T_{25}, t)\| \leq (\hat{k}_{24})^{(4)} \|T_{25} - T_{25}'\| e^{-(\hat{M}_{24})^{(4)} t}$ $\|(b_i'')^{(4)}((G_{27})', t) - (b_i'')^{(4)}((G_{27}), t)\| < (\hat{k}_{24})^{(4)} \|\|(G_{27}) - (G_{27})'\|\| e^{-(\hat{M}_{24})^{(4)} t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}', t)$ and$(a_i'')^{(4)}(T_{25}, t)$. (T_{25}', t) and (T_{25}, t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i'')^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i'')^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
__Definition of__ $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i^{'})^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i^{'})^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29}, t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}), t) \leq (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	122
$lim_{T_2 \to \infty}(a_i^{''})^{(5)}(T_{29}, t) = (p_i)^{(5)}$ $\lim_{G \to \infty}(b_i^{''})^{(5)}(G_{31}, t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\|(a_i^{''})^{(5)}(T_{29}^{'}, t) - (a_i^{''})^{(5)}(T_{29}, t)\| \leq (\hat{k}_{28})^{(5)}\|T_{29} - T_{29}^{'}\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i^{''})^{(5)}((G_{31})^{'}, t) - (b_i^{''})^{(5)}((G_{31}), t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31}) - (G_{31})^{'}\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'}, t)$ and $(a_i^{''})^{(5)}(T_{29}, t)$. $(T_{29}^{'}, t)$ and (T_{29}, t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}$, $\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
$lim_{T_2 \to \infty}(a_i'')^{(6)}(T_{33}, t) = (p_i)^{(6)}$ $\lim_{G \to \infty}(b_i'')^{(6)}\left((G_{35}), t\right) = (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\|(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\| \leq (\hat{k}_{32})^{(6)}\|T_{33} - T_{33}'\|e^{-(\hat{M}_{32})^{(6)}t}$ $\|(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}\left((G_{35}), t\right)\| < (\hat{k}_{32})^{(6)}\|\|(G_{35}) - (G_{35})'\|\|e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants	129

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and\ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(OOO) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (PPP) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39},t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(QQQ) $\lim_{T_2\to\infty} (a_i'')^{(7)}(T_{37},t) = (p_i)^{(7)}$ *(RRR)* $\lim_{G\to\infty}(b_i'')^{(7)}((G_{39}),t) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}',t) - (a_i'')^{(7)}(T_{37},t)\rvert \leq (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})',t) - (b_i'')^{(7)}((G_{39}),t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}',t)$ and $(a_i'')^{(7)}(T_{37},t)$. (T_{37}',t) and (T_{37},t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (SSS) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (TTT) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
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$\lim_{G \to \infty} (b_i'')^{(8)} \big((G_{43}), t\big) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert (a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t) \rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}' \rvert e^{-(\hat{M}_{40})^{(8)} t}$	142

$\|(b_i^{''})^{(8)}((G_{43})',t)-(b_i^{''})^{(8)}((G_{43}),t)\| < (\hat{k}_{40})^{(8)}\|\|(G_{43})-(G_{43})'\|\|e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}',t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)}=1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
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Definition of $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)},(r_i)^{(8)}, i=40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i')^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i^{''})^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i^{''})^{(9)} > 0, \quad i,j=44,45,46$ The functions $(a_i^{''})^{(9)},(b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t) \le (p_i)^{(9)} \le (\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t) \le (r_i)^{(9)} \le (b_i')^{(9)} \le (\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i^{''})^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i^{''})^{(9)}(G_{47},t)=(r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition:	

$\lvert(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)\rvert \le (\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}'\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)\rvert < (\hat{k}_{44})^{(9)}\lvert\lvert(G_{47})-(G_{47})'\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ ,\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
<u>**Definition of**</u> $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(p_i)^{(9)},\ (r_i)^{(9)},i=44,45,46,$ satisfy the inequalities $\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)}+(a_i')^{(9)}+\ (\hat{A}_{44})^{(9)}+\ (\hat{P}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}]<1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)}+(b_i')^{(9)}+\ (\hat{B}_{44})^{(9)}+\ (\hat{Q}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}]<1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>Definition of</u> $G_i(0)\,,T_i(0)$: $G_i(t)\le\ (\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}\ ,\ \boxed{G_i(0)=G_i^0>0}$ $T_i(t)\le\ (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}\ ,\ \boxed{T_i(0)=T_i^0>0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>**Definition of**</u> $G_i(0)\,,T_i(0)$ $G_i(t)\le\ (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}\ ,\quad G_i(0)=G_i^0>0$ $T_i(t)\le\ (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}\ ,\quad T_i(0)=T_i^0>0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t)\le\ (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}\ ,\quad G_i(0)=G_i^0>0$	149

$T_i(t) \leq \ (\hat{Q}_{20}\ )^{(3)} e^{(\hat{M}_{20}\ )^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **<u>Definition of</u>** $G_i(0)\ , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{24}\ )^{(4)} e^{(\hat{M}_{24}\ )^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24}\ )^{(4)} e^{(\hat{M}_{24}\ )^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
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Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **<u>Definition of</u>** $G_i(0)\ , T_i(0)$: $G_i(t) \leq \ (\hat{P}_{40}\ )^{(8)} e^{(\hat{M}_{40}\ )^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{40}\ )^{(8)} e^{(\hat{M}_{40}\ )^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **<u>Definition of</u>** $G_i(0)\ , T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44}\right)^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
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$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$,$T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	157
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$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$,$T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}')^{(2)} + (a_{18}'')^{(2)}\left(T_{17}(s_{(16)}), s_{(16)}\right)\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}')^{(2)} - (b_{16}'')^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}')^{(2)} - (b_{17}'')^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}')^{(2)} - (b_{18}'')^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)}\left(T_{21}(s_{(20)}), s_{(20)}\right)\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)}\left(T_{21}(s_{(20)}), s_{(20)}\right)\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)}\left(T_{21}(s_{(20)}), s_{(20)}\right)\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)}\left(G_{23}(s_{(20)}), s_{(20)}\right)\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)}\left(G_{23}(s_{(20)}), s_{(20)}\right)\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}\left(G_{23}(s_{(20)}), s_{(20)}\right)\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)}G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)}G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)}G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)}T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)}T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{\mathrm{T}}_{26}(\mathrm{t}) = \mathrm{T}_{26}^0 + \int_0^t \left[(b_{26})^{(4)}T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)}G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)}G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)}G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)}T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)}T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)}T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,, T_i(0) = T_i^0 \,, G_i^0 \leq (\hat{P}_{32})^{(6)} \,, T_i^0 \leq (\hat{Q}_{32})^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,, T_i(0) = T_i^0 \,, G_i^0 \leq (\hat{P}_{36})^{(7)} \,, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{40})^{(8)} , T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{44})^{(9)} , T_i^0 \leq (\hat{Q}_{44})^{(9)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14} , G_{15}, T_{13}, T_{14}, T_{15}	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17} , G_{18}, T_{16}, T_{17}, T_{18}	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for G_{21} , G_{22}, T_{20}, T_{21}, T_{22}	
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From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
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$T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{2}\right), \quad t = log\frac{2}{\varepsilon_1}$ By taking now ε_1 sufficiently small one sees that T_{14} is unbounded. The same property holds for T_{15} if $\lim_{t\to\infty}(b''_{15})^{(1)}(G(t),t) = (b'_{15})^{(1)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	
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Remark 22: There does not exist any t where $G_i(t) = 0$ and $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(5)} - (a_i'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\} ds_{(28)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(5)}t)} > 0$ for $t > 0$	239
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Then $\frac{dT_{29}}{dt} \geq (a_{29})^{(5)}(m)^{(5)} - \varepsilon_5 T_{29}$ which leads to $T_{29}\ \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{\varepsilon_5}\right)(1 - e^{-\varepsilon_5 t}) + T_{29}^0 e^{-\varepsilon_5 t}$ If we take t such that $e^{-\varepsilon_5 t} = \ \frac{1}{2}$ it results $T_{29}\ \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{2}\right),\quad t = log\frac{2}{\varepsilon_5}$ By taking now ε_5 sufficiently small one sees that T_{29} is unbounded. The same property holds for T_{30} if $\lim_{t\to\infty}(b_{30}'')^{(5)}\left((G_{31})(t),t\right) = (b_{30}')^{(5)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations Analogous inequalities hold also for $G_{33}\ ,G_{34},T_{32},T_{33},T_{34}$	243
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Remark 26: The fact that we supposed $(a''_{32})^{(6)}$ and $(b''_{32})^{(6)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{32})^{(6)}e^{(\widehat{M}_{32})^{(6)}t}$ *and* $(\widehat{Q}_{32})^{(6)}e^{(\widehat{M}_{32})^{(6)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(6)}$ and $(b''_i)^{(6)}, i=32,33,34$ depend only on T_{33} and respectively on $(G_{35})(\textit{and not on } t)$ and hypothesis can replaced by a usual Lipschitz condition.	249
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Definition of $\left((\widehat{M}_{32})^{(6)}\right)_1,\left((\widehat{M}_{32})^{(6)}\right)_2$ *and* $\left((\widehat{M}_{32})^{(6)}\right)_3$: **Remark 28:** if G_{32} is bounded, the same property have also G_{33} *and* G_{34} . indeed if $G_{32}<(\widehat{M}_{32})^{(6)}$ it follows $\frac{dG_{33}}{dt}\leq\left((\widehat{M}_{32})^{(6)}\right)_1-(a'_{33})^{(6)}G_{33}$ and by integrating $G_{33}\leq\left((\widehat{M}_{32})^{(6)}\right)_2=G_{33}^0+2(a_{33})^{(6)}\left((\widehat{M}_{32})^{(6)}\right)_1/(a'_{33})^{(6)}$ In the same way , one can obtain $G_{34}\leq\left((\widehat{M}_{32})^{(6)}\right)_3=G_{34}^0+2(a_{34})^{(6)}\left((\widehat{M}_{32})^{(6)}\right)_2/(a'_{34})^{(6)}$ If G_{33} *or* G_{34} is bounded, the same property follows for G_{32} , G_{34} and G_{32} , G_{33} respectively.	251
Remark 29: If G_{32} *is* bounded, from below, the same property holds for G_{33} *and* G_{34} . The proof is analogous with the preceding one. An analogous property is true if G_{33} is bounded from below.	252
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Indeed let t_6 be so that for $t > t_6$ $(b_{33})^{(6)} - (b_i'')^{(6)}\left((G_{35})(t), t\right) < \varepsilon_6, T_{32}\ (t) > (m)^{(6)}$	
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Analogous inequalities hold also for $G_{37}, G_{38}, T_{36}, T_{37}, T_{38}$ It is now sufficient to take $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$ and to choose $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ large to have	255
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$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[((\hat{Q}_{36})^{(7)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{36})^{(7)}\right] \leq (\hat{Q}_{36})^{(7)}$	257
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The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(\left((G_{39})^{(1)}, (T_{39})^{(1)}\right), \left((G_{39})^{(2)}, (T_{39})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \left\|G_i^{(1)}(t) - G_i^{(2)}(t)\right\| e^{-(\hat{M}_{36})^{(7)}t}, \max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t) - T_i^{(2)}(t)\right\| e^{-(\hat{M}_{36})^{(7)}t}\}$ Indeed if we denote **<u>Definition of</u>** $\widetilde{(G_{39})}, \widetilde{(T_{39})} : \left(\widetilde{(G_{39})}, \widetilde{(T_{39})}\right) = \mathcal{A}^{(7)}((G_{39}), (T_{39}))$ It results $\left\|\tilde{G}_{36}^{(1)} - \tilde{G}_i^{(2)}\right\| \leq \int_0^t (a_{36})^{(7)}\left\|G_{37}^{(1)} - G_{37}^{(2)}\right\| e^{-(\hat{M}_{36})^{(7)}s_{(36)}} e^{(\hat{M}_{36})^{(7)}s_{(36)}}\, ds_{(36)} +$ $\int_0^t\{(a_{36}')^{(7)}\left\|G_{36}^{(1)} - G_{36}^{(2)}\right\| e^{-(\hat{M}_{36})^{(7)}s_{(36)}} e^{-(\hat{M}_{36})^{(7)}s_{(36)}} +$ $(a_{36}'')^{(7)}\left(T_{37}^{(1)}, s_{(36)}\right)\left\|G_{36}^{(1)} - G_{36}^{(2)}\right\| e^{-(\hat{M}_{36})^{(7)}s_{(36)}} e^{(\hat{M}_{36})^{(7)}s_{(36)}} +$	258

$G_{36}^{(2)}\|(a_{36}'')^{(7)}(T_{37}^{(1)},s_{(36)})-(a_{36}'')^{(7)}(T_{37}^{(2)},s_{(36)})\|\ e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,t]$ From the hypotheses on it follows	
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If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
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$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[((\widehat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) = \sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\widehat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\widehat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})} : \big(\widetilde{(G_{47})},\widetilde{(T_{47})}\big) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$$
$$\int_0^t \{(a_{44}^{'})^{(9)} |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$$
$$(a_{44}^{''})^{(9)} (T_{45}^{(1)}, s_{(44)}) |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$$
$$G_{44}^{(2)} |(a_{44}^{''})^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a_{44}^{''})^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}| e^{-(\widehat{M}_{44})^{(9)} t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}^{'})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)} \right) d \left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)} \right) \right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}^{''})^{(9)}$ and $(b_{44}^{''})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)} \right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)} \right)_1, \left((\widehat{M}_{44})^{(9)} \right)_2$ *and* $\left((\widehat{M}_{44})^{(9)} \right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)} \right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$$G_{45} \leq \left((\widehat{M}_{44})^{(9)} \right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)} \right)_1 / (a_{45}^{'})^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq \left((\widehat{M}_{44})^{(9)} \right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)} \right)_2 / (a_{46}^{'})^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t),t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $$(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t),t) = (b_{46}')^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
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Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
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$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}\ , if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
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$\left(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}^{'})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}^{'})^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}^{'})^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}^{'})^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}^{'})^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}^{'})^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}^{'})^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}^{'})^{(1)}$ $(R_2)^{(1)} = (b_{15}^{'})^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}), t\right) - (b_{17}^{''})^{(2)}\left((G_{19}), t\right) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}$, ***if*** $(\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}$, ***if*** $(\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}$, ***if*** $(\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}$, ***if*** $(u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}$, ***if*** $(u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}$, ***if*** $(\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
<u>Definition of</u> $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},\ \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},\ \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})} \left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t} \right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq \right.$ $\left. \frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a_{22}')^{(3)})} \left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t} \right] + G_{22}^0 e^{-(a_{22}')^{(3)}t} \right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)} - (b_{22}')^{(3)})} \left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t} \right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)})} \left[e^{((R_1)^{(3)} + (r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t} \right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)}, \ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}, \boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)}, \ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)}, \ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}, \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \textbf{\textit{if}}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \le G_{24}(t) \le G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \le G_{25}(t) \le \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \le G_{26}(t) \le\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \le T_{24}(t) \le T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \le T_{24}(t) \le \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \le T_{26}(t) \le$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>**Definition of**</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \le -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29},t) + (a_{29}'')^{(5)}(T_{29},t) \le -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \le -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}),t) - (b_{29}'')^{(5)}((G_{31}),t) \le -(\tau_1)^{(5)}$	338
<u>**Definition of**</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
<u>Definition of</u> $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **<u>Definition of</u>** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},$ ***if*** $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},$ ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)},$ ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b'_{30})^{(5)}t}\right]+T_{30}^0 e^{-(b'_{30})^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)},(S_2)^{(5)},(R_1)^{(5)},(R_2)^{(5)}$:- Where $(S_1)^{(5)}=(a_{28})^{(5)}(m_2)^{(5)}-(a'_{28})^{(5)}$ $(S_2)^{(5)}=(a_{30})^{(5)}-(p_{30})^{(5)}$ $(R_1)^{(5)}=(b_{28})^{(5)}(\mu_2)^{(5)}-(b'_{28})^{(5)}$ $(R_2)^{(5)}=(b'_{30})^{(5)}-(r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$: $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)}\leq-(a'_{32})^{(6)}+(a'_{33})^{(6)}-(a''_{32})^{(6)}(T_{33},t)+(a''_{33})^{(6)}(T_{33},t)\leq-(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)}\leq-(b'_{32})^{(6)}+(b'_{33})^{(6)}-(b''_{32})^{(6)}\left((G_{35}),t\right)-(b''_{33})^{(6)}\left((G_{35}),t\right)\leq-(\tau_1)^{(6)}$	349
Definition of $(\nu_1)^{(6)},(\nu_2)^{(6)},(u_1)^{(6)},(u_2)^{(6)},\nu^{(6)},u^{(6)}$: By $(\nu_1)^{(6)}>0,(\nu_2)^{(6)}<0$ and respectively $(u_1)^{(6)}>0,(u_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_1)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},\boldsymbol{if}\ (\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)} t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)} t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)} t}\right] + G_{34}^0 e^{-(S_2)^{(6)} t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)} t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)} + (r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)} t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)} + (r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)} - (b_{34}')^{(6)})}\left[e^{(R_1)^{(6)} t} - e^{-(b_{34}')^{(6)} t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)} t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)} + (r_{32})^{(6)} + (R_2)^{(6)})}\left[e^{((R_1)^{(6)} + (r_{32})^{(6)})t} - e^{-(R_2)^{(6)} t}\right] + T_{34}^0 e^{-(R_2)^{(6)} t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} - (a_{36}^{''})^{(7)}(T_{37}, t) + (a_{37}^{''})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (b_{36}^{''})^{(7)}\big((G_{39}), t\big) - (b_{37}^{''})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},$ ***if*** $(\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},$ ***if*** $(\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},$ ***if*** $(\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},$ ***if*** $(u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)},$ ***if*** $(u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)},$ ***if*** $(\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t}-e^{-(S_2)^{(7)}t}\right]+G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t}-e^{-(a_{38}')^{(7)}t}\right]+G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t}-e^{-(b_{38}')^{(7)}t}\right]+T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}')^{(7)}$ $(R_2)^{(7)} = (b_{38}')^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}')^{(8)} + (a_{41}')^{(8)} - (a_{40}'')^{(8)}(T_{41}, t) + (a_{41}'')^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}')^{(8)} + (b_{41}')^{(8)} - (b_{40}'')^{(8)}\left((G_{43}), t\right) - (b_{41}'')^{(8)}\left((G_{43}), t\right) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_1)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ and	
Definition of $(\bar{\nu}_1)^{(8)},,(\bar{\nu}_2)^{(8)},(\bar{u}_1)^{(8)},(\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)}>0\,,(\bar{\nu}_2)^{(8)}<0$ and respectively $(\bar{u}_1)^{(8)}>0\,,(\bar{u}_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_2)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_2)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ **Definition of** $(m_1)^{(8)}\,,(m_2)^{(8)}\,,(\mu_1)^{(8)},(\mu_2)^{(8)},(\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}\,,(m_2)^{(8)}\,,(\mu_1)^{(8)},(\mu_2)^{(8)}$ by $(m_2)^{(8)}=(\nu_0)^{(8)},(m_1)^{(8)}=(\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)}<(\nu_1)^{(8)}$ $(m_2)^{(8)}=(\nu_1)^{(8)},(m_1)^{(8)}=(\bar{\nu}_1)^{(8)}\,,\boldsymbol{if}\ (\nu_1)^{(8)}<(\nu_0)^{(8)}<(\bar{\nu}_1)^{(8)},$ and $\boxed{(\nu_0)^{(8)}=\frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)}=(\nu_1)^{(8)},(m_1)^{(8)}=(\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)}<(\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)}=(u_0)^{(8)},(\mu_1)^{(8)}=(u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)}<(u_1)^{(8)}$ $(\mu_2)^{(8)}=(u_1)^{(8)},(\mu_1)^{(8)}=(\bar{u}_1)^{(8)}\,,\boldsymbol{if}\ (u_1)^{(8)}<(u_0)^{(8)}<(\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)}=\frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)}=(u_1)^{(8)},(\mu_1)^{(8)}=(u_0)^{(8)},\boldsymbol{if}\ (\bar{u}_1)^{(8)}<(u_0)^{(8)}$ where $(u_1)^{(8)},(\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{\left((S_1)^{(8)}-(p_{40})^{(8)}\right)t}\leq G_{40}(t)\leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}}G_{40}^0 e^{\left((S_1)^{(8)}-(p_{40})^{(8)}\right)t}\leq G_{41}(t)\leq\frac{1}{(m_2)^{(8)}}G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}\left((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)}\right)}\left[e^{\left((S_1)^{(8)}-(p_{40})^{(8)}\right)t}-e^{-(S_2)^{(8)}t}\right]+G_{42}^0 e^{-(S_2)^{(8)}t}\leq G_{42}(t)\leq\right.$ $\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}\left((S_1)^{(8)}-(a_{42}')^{(8)}\right)}\left[e^{(S_1)^{(8)}t}-e^{-(a_{42}')^{(8)}t}\right]+G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)}T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)}T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}((G_{47}), t) - (b''_{45})^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},$ ***if*** $(\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, $\boldsymbol{if}$ $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, $\boldsymbol{if}$ $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, $\boldsymbol{if}$ $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)} - (p_{44})^{(9)} - (S_2)^{(9)})} \left[e^{((S_1)^{(9)} - (p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)} - (a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t})$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)} + (r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)} + (r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)} - (b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)} + (r_{44})^{(9)} + (R_2)^{(9)})} \left[e^{((R_1)^{(9)} + (r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \le \frac{d\nu^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \ge \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \le \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \le \nu^{(1)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \le (\bar{\nu}_1)^{(1)} \le \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \le \nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
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In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
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Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}')^{(3)} - (a_{21}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right) - (a_{21}'')^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
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If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
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Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)},\quad\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)},\quad\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

__**Proof**__ : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

__**Definition of**__ $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

__**Definition of**__ $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}, \quad \boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}, \quad \boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)}=\frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t)=\frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t)=\frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}^{''})^{(9)} = (a_{45}^{''})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}^{''})^{(9)} = (b_{45}^{''})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i^{''})^{(1)} and\ (b_i^{''})^{(1)}$ are independent on t , and the conditions with the notations

$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}^{'})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b'_{44})^{(9)}(r_{45})^{(9)} - (b'_{45})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\,]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\,]T_{46} = 0$	
<u>**Proof:**</u> (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
<u>**Proof:**</u> (l) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T^*_{17} for which $f(T^*_{17}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	495
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Definition and uniqueness of T^*_{25} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T^*_{25} for which $f(T^*_{25}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a'_{24})^{(4)}+(a''_{24})^{(4)}(T^*_{25})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a'_{26})^{(4)}+(a''_{26})^{(4)}(T^*_{25})]}$	497
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equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
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Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
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By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31}) + (b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right] + (b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
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By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b_{40}^{'})^{(8)}(b_{41}^{''})^{(8)}(G_{43}) + (b_{41}^{'})^{(8)}(b_{40}^{''})^{(8)}(G_{43})\right]+(b_{40}^{''})^{(8)}(G_{43})(b_{41}^{''})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^{*} such that $\varphi(G_{43}{}^{*}) = 0$	510
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Finally we obtain the unique solution G_{14}^{*} given by $\varphi(G^{*}) = 0$, T_{14}^{*} given by $f(T_{14}^{*}) = 0$ and $G_{13}^{*} = \frac{(a_{13})^{(1)}G_{14}^{*}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15}^{*} = \frac{(a_{15})^{(1)}G_{14}^{*}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$ $T_{13}^{*} = \frac{(b_{13})^{(1)}T_{14}^{*}}{[(b_{13}^{'})^{(1)}-(b_{13}^{''})^{(1)}(G^{*})]}$, $T_{15}^{*} = \frac{(b_{15})^{(1)}T_{14}^{*}}{[(b_{15}^{'})^{(1)}-(b_{15}^{''})^{(1)}(G^{*})]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^{*} given by $\varphi((G_{19})^{*}) = 0$, T_{17}^{*} given by $f(T_{17}^{*}) = 0$ and	512
$G_{16}^{*} = \frac{(a_{16})^{(2)}G_{17}^{*}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18}^{*} = \frac{(a_{18})^{(2)}G_{17}^{*}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	513
$T_{16}^{*} = \frac{(b_{16})^{(2)}T_{17}^{*}}{[(b_{16}^{'})^{(2)}-(b_{16}^{''})^{(2)}((G_{19})^{*})]}$, $T_{18}^{*} = \frac{(b_{18})^{(2)}T_{17}^{*}}{[(b_{18}^{'})^{(2)}-(b_{18}^{''})^{(2)}((G_{19})^{*})]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^{*} given by $\varphi((G_{23})^{*}) = 0$, T_{21}^{*} given by $f(T_{21}^{*}) = 0$ and $G_{20}^{*} = \frac{(a_{20})^{(3)}G_{21}^{*}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22}^{*} = \frac{(a_{22})^{(3)}G_{21}^{*}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$ $T_{20}^{*} = \frac{(b_{20})^{(3)}T_{21}^{*}}{[(b_{20}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23}{}^{*})]}$, $T_{22}^{*} = \frac{(b_{22})^{(3)}T_{21}^{*}}{[(b_{22}^{'})^{(3)}-(b_{22}^{''})^{(3)}(G_{23}{}^{*})]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial \mathbb{T}_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial(b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial(b_i^{''})^{(5)}}{\partial G_j}(\,(G_{31})^{*}\,) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt}=-\left((a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\mathbb{G}_{28}+(a_{28})^{(5)}\mathbb{G}_{29}-(q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt}=-\left((a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)\mathbb{G}_{29}+(a_{29})^{(5)}\mathbb{G}_{28}-(q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt}=-\left((a_{30}^{'})^{(5)}+(p_{30})^{(5)}\right)\mathbb{G}_{30}+(a_{30})^{(5)}\mathbb{G}_{29}-(q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt}=-\left((b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)\mathbb{T}_{28}+(b_{28})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_{j}\right)$	560
$\frac{d\mathbb{T}_{29}}{dt}=-\left((b_{29}^{'})^{(5)}-(r_{29})^{(5)}\right)\mathbb{T}_{29}+(b_{29})^{(5)}\mathbb{T}_{28}+\sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_{j}\right)$	561
$\frac{d\mathbb{T}_{30}}{dt}=-\left((b_{30}^{'})^{(5)}-(r_{30})^{(5)}\right)\mathbb{T}_{30}+(b_{30})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_{j}\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \qquad , T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*})=(q_{33})^{(6)} \quad , \frac{\partial(b_i^{''})^{(6)}}{\partial G_j}\left((G_{35})^{*}\right)=s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt}=-\left((a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\mathbb{G}_{32}+(a_{32})^{(6)}\mathbb{G}_{33}-(q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt}=-\left((a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)\mathbb{G}_{33}+(a_{33})^{(6)}\mathbb{G}_{32}-(q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt}=-\left((a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)\mathbb{G}_{34}+(a_{34})^{(6)}\mathbb{G}_{33}-(q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt}=-\left((b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)\mathbb{T}_{32}+(b_{32})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_{j}\right)$	568
$\frac{d\mathbb{T}_{33}}{dt}=-\left((b_{33}^{'})^{(6)}-(r_{33})^{(6)}\right)\mathbb{T}_{33}+(b_{33})^{(6)}\mathbb{T}_{32}+\sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_{j}\right)$	569
$\frac{d\mathbb{T}_{34}}{dt}=-\left((b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\mathbb{T}_{34}+(b_{34})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_{j}\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_{+})$ then the above equilibrium point is asymptotically stable. **<u>Proof:</u> Denote**	586 A
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$+\Big(\big((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\big)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\Big)$

$\Big(\big((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\big)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\Big)$

$\Big(\big((\lambda)^{(1)}\big)^{2}+\big((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\big)(\lambda)^{(1)}\Big)$

$\Big(\big((\lambda)^{(1)}\big)^{2}+\big((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\big)(\lambda)^{(1)}\Big)$

$+\Big(\big((\lambda)^{(1)}\big)^{2}+\big((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\big)(\lambda)^{(1)}\Big)(q_{15})^{(1)}G_{15}$

$+\big((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\big)\big((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\big)$

$\Big(\big((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\big)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\Big)\}=0$

+

$\big((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\big)\{\big((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\big)$

$\Big[\Big(\big((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\big)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\Big)\Big]$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\Big)$

$+\Big(\big((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\big)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\Big)$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\Big)$

$\Big(\big((\lambda)^{(2)}\big)^{2}+\big((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\big)(\lambda)^{(2)}\Big)$

$\Big(\big((\lambda)^{(2)}\big)^{2}+\big((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\big)(\lambda)^{(2)}\Big)$

$+\Big(\big((\lambda)^{(2)}\big)^{2}+\big((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\big)(\lambda)^{(2)}\Big)(q_{18})^{(2)}G_{18}$

$+\big((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\big)\big((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\big)$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\Big)\}=0$

+

$\big((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\big)\{\big((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\big)$

$\Big[\Big(\big((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\big)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\Big)\Big]$

$\Big(\big((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\big)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\Big)$

$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$ +	
$((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)})$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)})$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$	

$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$

$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$

$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$

$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$

$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$

$+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$

$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$

$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$

$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$

$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$

$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$

$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$

$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$

$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$

$$+\left(\left((\lambda)^{(7)}+(a_{37}')^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}')^{(7)}+(b_{37}')^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b_{42}')^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}')^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}')^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}')^{(8)}+(b_{41}')^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b_{46}')^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}')^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(\left((\lambda)^{(9)}+(a_{45}')^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION THIRTEEN

Dense Chern-Simons Matter With Fermions At Large

INTRODUCTION—VARIABLES USED

Dense Chern-Simons Matter with Fermions at Large N Michael Geracie, Mikhail Goykhman, Dam T. Son

(1) In this paper authors investigate properties of Chern-Simons theory coupled to (e&eb) massive fermions in the large N limit.

(2) They demonstrate that at low temperatures the system is (=) in a Fermi liquid state whose features can be systematically compared to (e&eb) the standard phenomenological theory of (e) Landau Fermi liquids.

(3) This includes matching microscopically derived Landau parameters with (e&eb) thermodynamic predictions of Landau Fermi liquid theory.

(4) They also calculate the exact conductivity and (e&eb) viscosity tensors at zero temperature and finite chemical potential.

(5) In particular they point out that the Hall conductivity of (e) an interacting system is not (e) entirely accounted for (e) by the Berry flux through (e&eb) the Fermi sphere.

(6) Furthermore, investigation of the thermodynamics in the non-relativistic limit reveals (eb) novel phenomena at strong coupling. **(7)** As the't Hooft coupling approaches 1, the system exhibits (eb) an extended intermediate temperature regime in which the thermodynamics is described by (e) neither the quantum Fermi liquid theory nor the classical ideal gas law. **(8)** Instead, it can be interpreted as (=) a weakly coupled quantum Bose gas. Subjects: High Energy Physics - Theory (hep-th); Strongly Correlated Electrons (cond-mat.str-el) Cite as: arXiv:1511.04772 [hep-th] (or arXiv:1511.04772v1 [hep-th] for this version	
NOTATION	
Module One In this paper authors investigate properties of Chern-Simons theory coupled to (e&eb) massive fermions in the large N limit	
G_{13} : Category one of **Chern-Simons theory;** massive fermions in the large N limit G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of massive fermions in the large N limit **;Chern-Simons theory** T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two They demonstrate that the system at low temperatures is in a Fermi liquid state whose features can be systematically compared to (e&eb) the standard phenomenological theory of Landau Fermi liquids	
G_{16} : Category one of **system at low temperatures is in a Fermi liquid state whose features;** standard phenomenological theory of Landau Fermi liquids G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of standard phenomenological theory of Landau Fermi liquids **;system at low temperatures is in a Fermi liquid state whose features** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three This includes matching microscopically derived Landau parameters with (e&eb) thermodynamic predictions of Landau Fermi liquid theory	
G_{20} : Category one of **microscopically derived Landau parameters;** thermodynamic predictions of Landau Fermi liquid theory G_{21} : Category two of SAS	

G_{22} : Category three of SAS	
T_{20} : Category one of thermodynamic predictions of Landau Fermi liquid theory **; microscopically derived Landau parameters** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four They also calculate the exact conductivity and (e&eb) viscosity tensors at zero temperature and finite chemical potential	
G_{24} : Category one of **exact conductivity;** viscosity tensors at zero temperature G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of viscosity tensors at zero temperature; **exact conductivity** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five They also calculate the exact conductivity and viscosity tensors at zero temperature and finite chemical potential	
G_{28} : Category one of **exact conductivity and viscosity tensors at zero temperature;** finite chemical potential G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of finite chemical potential **;exact conductivity and viscosity tensors at zero temperature** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six In particular they point out that the Hall conductivity of (e) an interacting system is not (e) entirely accounted for (e) by the Berry flux through (e&eb) the Fermi sphere.	
G_{32} : Category one of interacting system is not (e) entirely accounted for (e) by the Berry flux through (e&eb) the Fermi sphere G_{33} : Category two of SAS	

G_{34} : Category three of SAS	
T_{32} : Category one of Hall conductivity T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven In particular they point out that the Hall conductivity of an interacting system is not (e) entirely accounted for (e) by the Berry flux through (e&eb) the Fermi sphere	
G_{36} : Category one of entirely accounted for (e) by the Berry flux through (e&eb) the Fermi sphere G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of Hall conductivity of an interacting system T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight In particular they point out that the Hall conductivity of an interacting system is not entirely accounted for by the Berry flux through (e&eb) the Fermi sphere	
G_{40} : Category one of **Hall conductivity of an interacting system is not entirely accounted for by the Berry flux;** Fermi sphere G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of Fermi sphere **; Hall conductivity of an interacting system is not entirely accounted for by the Berry flux** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine As the't Hooft coupling approaches 1, the system exhibits (eb) an extended intermediate temperature regime in which the thermodynamics is described by (e) neither the quantum Fermi liquid theory nor the classical ideal gas law	
G_{44} : Category one of 't Hooft coupling approaches 1	

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of extended intermediate temperature regime in which the thermodynamics is described by (e) neither the quantum Fermi liquid theory nor the classical ideal gas law

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:

$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$:
$(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$
$(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$,
$(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$
$(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$
$(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$
$(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$

are Accentuation coefficients
$(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$
, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$
$(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$,
$(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$
$(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$,
$(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$,
$(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$,
are Dissipation coefficients

Module Numbered One

The differential system of this model is now (Module Numbered one)

$$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right] G_{13} \quad 1$$

$$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t)\right] G_{14} \quad 2$$

$$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t)\right] G_{15} \quad 3$$

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t)\right] T_{13} \quad 4$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t)\right] T_{14} \quad 5$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t)\right] T_{15} \quad 6$$

$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor

$-(b''_{13})^{(1)}(G, t) =$ First detritions factor

Module Numbered Two

The differential system of this model is now (Module numbered two)

$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28

$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}), t\right)\right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}), t\right)\right] T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29}, t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}), t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}, t)\right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}, t)\right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}, t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}), t\right)\right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}), t\right)\right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}), t\right)\right] T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}, t)\right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}, t)\right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}, t)\right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}), t\right)\right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}), t\right)\right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}), t\right)\right] T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}, t)\right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}, t)\right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}, t)\right] G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}, t)\right] G_{44}$	49

$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}((G_{47}),t)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}((G_{47}),t)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}((G_{47}),t)\right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}((G_{47}),t) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*55*
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	*56*
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	*57*
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58

$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	60
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \begin{bmatrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \begin{bmatrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \begin{bmatrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$$ 64

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$$ 65

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$$ 66

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b_{36}'')^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b_{40}'')^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b_{44}'')^{(9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a_{20}')^{(3)} \boxed{+(a_{20}'')^{(3)}(T_{21},t)} \boxed{+(a_{16}'')^{(2,2,2)}(T_{17},t)} \boxed{+(a_{13}'')^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a_{21}')^{(3)} \boxed{+(a_{21}'')^{(3)}(T_{21},t)} \boxed{+(a_{17}'')^{(2,2,2)}(T_{17},t)} \boxed{+(a_{14}'')^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a_{22}')^{(3)} \boxed{+(a_{22}'')^{(3)}(T_{21},t)} \boxed{+(a_{18}'')^{(2,2,2)}(T_{17},t)} \boxed{+(a_{15}'')^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22}$	69
$\boxed{+(a_{20}'')^{(3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}'')^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{36}'')^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{40}'')^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{44}'')^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b_{20}')^{(3)} \boxed{-(b_{20}'')^{(3)}(G_{23},t)} \boxed{-(b_{16}'')^{(2,2,2)}(G_{19},t)} \boxed{-(b_{13}'')^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{20}$	70

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1, 2\ \ 3$

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation*

coefficient for category 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$

are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$

are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$

are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$

are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$

are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{28} \quad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{29} \quad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{30} \quad 81$$

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{28} \quad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$$	83
$$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$$	85
$$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$$	86
$$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3	

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32}$	*88*
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33}$	*89*
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34}$	*90*
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3	

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	92
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	93
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3	

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$\frac{dT_{40}}{dt} =$

$$(b_{40})^{(8)}T_{41}-\left[\begin{matrix}(b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{13}$$

$$\frac{dT_{41}}{dt}=$$

$$(b_{41})^{(8)}T_{40}-\left[\begin{matrix}(b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{14}$$

$$\frac{dT_{42}}{dt}=$$

$$(b_{42})^{(8)}T_{41}-\left[\begin{matrix}(b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt}=(a_{44})^{(9)}G_{45}-\left[\begin{matrix}(a'_{44})^{(9)}\boxed{+(a''_{44})^{(9)}(T_{45},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}\end{matrix}\right]G_{13}$$ 96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a'_{45})^{(9)}\boxed{+(a''_{45})^{(9)}(T_{45},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)}\boxed{+(a''_{46})^{(9)}(T_{37},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)}\boxed{-(b''_{44})^{(9)}(G_{47},t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$(b_{45})^{(9)}T_{44}-\left[\begin{matrix}(b_{45}')^{(9)}\boxed{-(b_{45}'')^{(9)}(G_{47},t)} & \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{matrix}\right]T_{14}$	
$\frac{dT_{46}}{dt}=$ $(b_{46})^{(9)}T_{45}-\left[\begin{matrix}(b_{46}')^{(9)}\boxed{-(b_{46}'')^{(9)}(G_{47},t)} & \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{matrix}\right]T_{15}$	
Where $\boxed{-(b_{44}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)},(a_i')^{(1)},(a_i'')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(b_i'')^{(1)}>0,\quad i,j=13,14,15$ The functions $(a_i'')^{(1)},(b_i'')^{(1)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(1)},\ (r_i)^{(1)}$: $(a_i'')^{(1)}(T_{14},t)\le(p_i)^{(1)}\le(\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t)\le\ (r_i)^{(1)}\le(b_i')^{(1)}\le(\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t)=(p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t)=\ (r_i)^{(1)}$	98

Definition of $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(\mathrm{p_i})^{(2)}, (\mathrm{r_i})^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty} (a_i'')^{(2)} (T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty} (b_i'')^{(2)} ((G_{19}),t) = (r_i)^{(2)}$	105

Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}}$ are positive constants and $\boxed{i = 16,17,18}$	106
They satisfy Lipschitz condition:	
$\|(a_i'')^{(2)}(T_{17}', t) - (a_i'')^{(2)}(T_{17}, t)\| \leq (\hat{k}_{16})^{(2)}\|T_{17} - T_{17}'\|e^{-(\hat{M}_{16})^{(2)}t}$	107
$\|(b_i'')^{(2)}((G_{19})', t) - (b_i'')^{(2)}\big((G_{19}), t\big)\| < (\hat{k}_{16})^{(2)}\|\|(G_{19}) - (G_{19})'\|\|e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}', t)$ and $(a_i'')^{(2)}(T_{17}, t)$. (T_{17}', t) and (T_{17}, t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} \ , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and \ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)} + (a_i')^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i')^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i, j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty}(a_i'')^{(3)}\ (T_{21}, t) = (p_i)^{(3)}$	113

$\lim_{G\to\infty}(b_i^{''})^{(3)}(G_{23},t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(3)}(T_{21}^{'},t) - (a_i^{''})^{(3)}(T_{21},t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}^{'}\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i^{''})^{(3)}(G_{23}{'},t) - (b_i^{''})^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}{'}\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'},t)$ and $(a_i^{''})^{(3)}(T_{21},t)$. $(T_{21}^{'},t)$ And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$	118

$\lim_{G\to\infty}(b_i^{''})^{(4)}\left((G_{27}),t\right) = (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}\left((G_{27}),t\right)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i^{'})^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i^{'})^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}\left((G_{31}),t\right) \leq (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	122

$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}$ are positive constants and $i = 28,29,30$	123
They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t) - (a_i'')^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t) - (b_i'')^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$	127

$(b_i^{''})^{(6)}((G_{35}),t) \leq (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(6)}(T_{33},t) = (p_i)^{(6)}$ $\lim_{G\to\infty}(b_i^{''})^{(6)}\left((G_{35}),t\right) = (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)},(p_i)^{(6)},\ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\|(a_i^{''})^{(6)}(T_{33}^{'},t) - (a_i^{''})^{(6)}(T_{33},t)\| \leq (\hat{k}_{32})^{(6)}\|T_{33} - T_{33}^{'}\|e^{-(\hat{M}_{32})^{(6)}t}$ $\|(b_i^{''})^{(6)}((G_{35})^{'},t) - (b_i^{''})^{(6)}\left((G_{35}),t\right)\| < (\hat{k}_{32})^{(6)}\|\|(G_{35}) - (G_{35})^{'}\|\|e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'},t)$ and $(a_i^{''})^{(6)}(T_{33},t)$. $(T_{33}^{'},t)$ and (T_{33},t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)},(\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)},(\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)},(\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\ ,\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
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Where we suppose	
(UUU) $(a_i)^{(7)},(a_i^{'})^{(7)},(a_i^{''})^{(7)},(b_i)^{(7)},(b_i^{'})^{(7)},(b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (VVV) The functions $(a_i^{''})^{(7)},(b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)},\ (r_i)^{(7)}$:	131

$(a_i^{''})^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39},t) \leq (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	
(WWW) $\lim_{T_2\to\infty} (a_i^{''})^{(7)}(T_{37},t) = (p_i)^{(7)}$ *(XXX)* $\lim_{G\to\infty} (b_i^{''})^{(7)}\big((G_{39}),t\big) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$	132
They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(7)}(T_{37}^{'},t) - (a_i^{''})^{(7)}(T_{37},t)\rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}^{'} \rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert (b_i^{''})^{(7)}((G_{39})^{'},t) - (b_i^{''})^{(7)}\big((G_{39}),t\big)\rvert < (\hat{k}_{36})^{(7)} \lvert\lvert (G_{39}) - (G_{39})^{'} \rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'},t)$ and $(a_i^{''})^{(7)}(T_{37},t)$. $(T_{37}^{'},t)$ and (T_{37},t) are points belonging to the interval $\big[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\big]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (YYY) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (ZZZ) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)}$ *and* $(\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i^{'})^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i^{'})^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	

$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i, j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, \ (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}), t) \leq \ (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
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Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t)\rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}' \rvert e^{-(\hat{M}_{40})^{(8)} t}$	142
$\lvert(b_i'')^{(8)}((G_{43})', t) - (b_i'')^{(8)}\left((G_{43}), t\right)\rvert < (\hat{k}_{40})^{(8)} \lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)} t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}', t)$ and $(a_i'')^{(8)}(T_{41}, t)$. (T_{41}', t) and (T_{41}, t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}} \ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}} [\,(a_i)^{(8)} + (a_i')^{(8)} + \ (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)} (\hat{k}_{40})^{(8)}] < 1$	145

$\frac{1}{(\hat{M}_{40})^{(8)}}[\ (b_i)^{(8)}+(b_i^{'})^{(8)}+\ (\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}\ (\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i^{'})^{(9)},(a_i^{''})^{(9)},(b_i)^{(9)},(b_i^{'})^{(9)},(b_i^{''})^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i^{''})^{(9)},(b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(9)},\ (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t)\le(p_i)^{(9)}\le(\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t)\le\ (r_i)^{(9)}\le(b_i^{'})^{(9)}\le(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i^{''})^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i^{''})^{(9)}(G_{47},t)=\ (r_i)^{(9)}$ **<u>Definition of</u>** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $\boxed{(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)}}$ are positive constants and $\boxed{i=44,45,46}$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(9)}(T_{45}^{'},t)-(a_i^{''})^{(9)}(T_{45},t)\rvert\le(\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}^{'}\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i^{''})^{(9)}((G_{47})^{'},t)-(b_i^{''})^{(9)}((G_{47}),t)\rvert<(\hat{k}_{44})^{(9)}\lvert\lvert(G_{47})-(G_{47})^{'}\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $\left[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}\right]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ ,\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
<u>Definition of</u> $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i^{'})^{(9)},(b_i)^{(9)},(b_i^{'})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)},i=44,45,46,$ satisfy the inequalities	

$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i')^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i')^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t)\leq(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $G_i(0)=G_i^0>0$ $T_i(t)\leq(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $T_i(0)=T_i^0>0$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t)\leq(\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0)=G_i^0>0$ $T_i(t)\leq(\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0)=T_i^0>0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t)\leq(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0)=G_i^0>0$ $T_i(t)\leq(\hat{Q}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0)=T_i^0>0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t)\leq(\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}t}$, $G_i(0)=G_i^0>0$ $T_i(t)\leq(\hat{Q}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}t}$, $T_i(0)=T_i^0>0$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t)\leq(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$, $G_i(0)=G_i^0>0$ $T_i(t)\leq(\hat{Q}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$, $T_i(0)=T_i^0>0$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	152

$G_i(t) \leq \left(\hat{P}_{32} \right)^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>**Definition of**</u> $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>**Definition of**</u> $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>**Definition of**</u> $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
<u>**Proof:**</u> Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)} \right) \right) G_{13}\left(s_{(13)}\right) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}\left(s_{(13)}\right) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)} \right) \right) G_{14}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)} \right) \right) G_{15}\left(s_{(13)}\right) \right] ds_{(13)}$	

$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{16})^{(2)}, T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0\leq(\hat{P}_{28})^{(5)}\ ,T_i^0\leq(\hat{Q}_{28})^{(5)},$	
$0\leq G_i(t)-G_i^0\leq(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$	
$0\leq T_i(t)-T_i^0\leq(\hat{Q}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$	
By $\bar{G}_{28}(t)=G_{28}^0+\int_0^t\left[(a_{28})^{(5)}G_{29}(s_{(28)})-\left((a_{28}^{'})^{(5)}+a_{28}^{''})^{(5)}(T_{29}(s_{(28)}),s_{(28)})\right)G_{28}(s_{(28)})\right]ds_{(28)}$	163
$\bar{G}_{29}(t)=G_{29}^0+\int_0^t\left[(a_{29})^{(5)}G_{28}(s_{(28)})-\left((a_{29}^{'})^{(5)}+(a_{29}^{''})^{(5)}(T_{29}(s_{(28)}),s_{(28)})\right)G_{29}(s_{(28)})\right]ds_{(28)}$	
$\bar{G}_{30}(t)=G_{30}^0+\int_0^t\left[(a_{30})^{(5)}G_{29}(s_{(28)})-\left((a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}(s_{(28)}),s_{(28)})\right)G_{30}(s_{(28)})\right]ds_{(28)}$	
$\bar{T}_{28}(t)=T_{28}^0+\int_0^t\left[(b_{28})^{(5)}T_{29}(s_{(28)})-\left((b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}(G_{31}(s_{(28)}),s_{(28)})\right)T_{28}(s_{(28)})\right]ds_{(28)}$	
$\bar{T}_{29}(t)=T_{29}^0+\int_0^t\left[(b_{29})^{(5)}T_{28}(s_{(28)})-\left((b_{29}^{'})^{(5)}-(b_{29}^{''})^{(5)}(G_{31}(s_{(28)}),s_{(28)})\right)T_{29}(s_{(28)})\right]ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t})=\mathrm{T}_{30}^0+\int_0^t\left[(b_{30})^{(5)}T_{29}(s_{(28)})-\left((b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}(G_{31}(s_{(28)}),s_{(28)})\right)T_{30}(s_{(28)})\right]ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i:\mathbb{R}_+\rightarrow\mathbb{R}_+$ which satisfy	
$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0\leq(\hat{P}_{32})^{(6)}\ ,T_i^0\leq(\hat{Q}_{32})^{(6)},$	
$0\leq G_i(t)-G_i^0\leq(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$	
$0\leq T_i(t)-T_i^0\leq(\hat{Q}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$	
By $\bar{G}_{32}(t)=G_{32}^0+\int_0^t\left[(a_{32})^{(6)}G_{33}(s_{(32)})-\left((a_{32}^{'})^{(6)}+a_{32}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{32}(s_{(32)})\right]ds_{(32)}$	164
$\bar{G}_{33}(t)=G_{33}^0+\int_0^t\left[(a_{33})^{(6)}G_{32}(s_{(32)})-\left((a_{33}^{'})^{(6)}+(a_{33}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{33}(s_{(32)})\right]ds_{(32)}$	
$\bar{G}_{34}(t)=G_{34}^0+\int_0^t\left[(a_{34})^{(6)}G_{33}(s_{(32)})-\left((a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{34}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{32}(t)=T_{32}^0+\int_0^t\left[(b_{32})^{(6)}T_{33}(s_{(32)})-\left((b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{32}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{33}(t)=T_{33}^0+\int_0^t\left[(b_{33})^{(6)}T_{32}(s_{(32)})-\left((b_{33}^{'})^{(6)}-(b_{33}^{''})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{33}(s_{(32)})\right]ds_{(32)}$	

$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}')^{(6)} - (b_{34}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{36})^{(7)}, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}')^{(7)} + a_{36}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}')^{(7)} - (b_{36}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}')^{(7)} - (b_{37}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}')^{(7)} - (b_{38}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

By	166
$\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$, $T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	167

$G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0 \right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0} \right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}} \right) \right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1 \right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0 \right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0} \right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that	174

$(G_{24}(t) - G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)} + G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)} + (\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)}\left(G_{29}^0+(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\right)\right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)}t\right)G_{29}^0 + \frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t} - 1\right)$	
From which it follows that $(G_{28}(t) - G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{P}_{28})^{(5)} + G_{29}^0\right)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)} + (\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)}\left(G_{33}^0+(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}s_{(32)}}\right)\right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)}t\right)G_{33}^0 + \frac{(a_{32})^{(6)}(\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left(e^{(\hat{M}_{32})^{(6)}t} - 1\right)$	176
From which it follows that $(G_{32}(t) - G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)} + G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)} + (\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for G_{25} , G_{26}, T_{24}, T_{25}, T_{26}	177
(m) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)}t\right)G_{37}^0 + \frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t} - 1\right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$	

(G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}}\right)\right] ds_{(40)} =$ $\left(1 + (a_{40})^{(8)} t\right) G_{41}^0 + \frac{(a_{40})^{(8)} (\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}} \left(e^{(\hat{M}_{40})^{(8)} t} - 1\right)$	180
From which it follows that $(G_{40}(t) - G_{40}^0) e^{-(\hat{M}_{40})^{(8)} t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}} \left[\left((\hat{P}_{40})^{(8)} + G_{41}^0\right) e^{\left(-\frac{(\hat{P}_{40})^{(8)} + G_{41}^0}{G_{41}^0}\right)} + (\hat{P}_{40})^{(8)} \right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41} , G_{42}, T_{40}, T_{41}, T_{42}	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} \left(G_{45}^0 + (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} s_{(44)}}\right)\right] ds_{(44)} =$ $\left(1 + (a_{44})^{(9)} t\right) G_{45}^0 + \frac{(a_{44})^{(9)} (\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}} \left(e^{(\hat{M}_{44})^{(9)} t} - 1\right)$	
From which it follows that $(G_{44}(t) - G_{44}^0) e^{-(\hat{M}_{44})^{(9)} t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}} \left[\left((\hat{P}_{44})^{(9)} + G_{45}^0\right) e^{\left(-\frac{(\hat{P}_{44})^{(9)} + G_{45}^0}{G_{45}^0}\right)} + (\hat{P}_{44})^{(9)} \right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45} , G_{46}, T_{44}, T_{45}, T_{46}	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
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$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{Q}_{13})^{(1)} + T_j^0\right) e^{-\left(\frac{(\hat{Q}_{13})^{(1)} + T_j^0}{T_j^0}\right)} + (\hat{Q}_{13})^{(1)} \right] \leq (\hat{Q}_{13})^{(1)}$	184
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$d\left(((G_{43})^{(1)},(T_{43})^{(1)}),((G_{43})^{(2)},(T_{43})^{(2)})\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
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It results $\lvert\tilde{G}_{40}^{(1)}-\tilde{G}_i^{(2)}\rvert\le\int_0^t(a_{40})^{(8)}\lvert G_{41}^{(1)}-G_{41}^{(2)}\rvert e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}ds_{(40)}+$ $\int_0^t\{(a_{40}^{'})^{(8)}\lvert G_{40}^{(1)}-G_{40}^{(2)}\rvert e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{-(\hat{M}_{40})^{(8)}s_{(40)}}+$ $(a_{40}^{''})^{(8)}(T_{41}^{(1)},s_{(40)})\lvert G_{40}^{(1)}-G_{40}^{(2)}\rvert e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}+$ $G_{40}^{(2)}\lvert(a_{40}^{''})^{(8)}(T_{41}^{(1)},s_{(40)})-(a_{40}^{''})^{(8)}(T_{41}^{(2)},s_{(40)})\rvert\; e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\}ds_{(40)}$	271
Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,t]$ From the hypotheses it follows	272
$\lvert(G_{43})^{(1)}-(G_{43})^{(2)}\rvert e^{-(\hat{M}_{40})^{(8)}t}\le$ $\frac{1}{(\hat{M}_{40})^{(8)}}\left((a_{40})^{(8)}+(a_{40}^{'})^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}\right)d\left(((G_{43})^{(1)},(T_{43})^{(1)};\;(G_{43})^{(2)},(T_{43})^{(2)})\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
Remark 36: The fact that we supposed $(a_{40}^{''})^{(8)}$ and $(b_{40}^{''})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate	274

condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ *and* $(\widehat{Q}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on $(G_{43})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 37 There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)} - (a_i'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for t > 0	275
Definition of $((\widehat{M}_{40})^{(8)})_1, ((\widehat{M}_{40})^{(8)})_2$ *and* $((\widehat{M}_{40})^{(8)})_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq ((\widehat{M}_{40})^{(8)})_1 - (a_{41}')^{(8)}G_{41}$ and by integrating $G_{41} \leq ((\widehat{M}_{40})^{(8)})_2 = G_{41}^0 + 2(a_{41})^{(8)}((\widehat{M}_{40})^{(8)})_1/(a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \leq ((\widehat{M}_{40})^{(8)})_3 = G_{42}^0 + 2(a_{42})^{(8)}((\widehat{M}_{40})^{(8)})_2/(a_{42}')^{(8)}$ If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	276
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Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t), t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}((G_{43})(t), t) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results	279

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right)$, $t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}^{''})^{(8)}\left((G_{43})(t), t(t), t\right) = (b_{42}^{'})^{(8)}$	
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + ((\widehat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[((\widehat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\widehat{M}_{44})^{(9)}t}\}$ Indeed if we denote **<u>Definition of</u>** $\widetilde{(G_{47})}, \widetilde{(T_{47})} : \left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}), (T_{47})\right)$ It results $\lvert\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{44})^{(9)}\lvert G_{45}^{(1)} - G_{45}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}ds_{(44)} +$ $\int_0^t\{(a_{44}^{'})^{(9)}\lvert G_{44}^{(1)} - G_{44}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} +$ $(a_{44}^{''})^{(9)}(T_{45}^{(1)}, s_{(44)})\lvert G_{44}^{(1)} - G_{44}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}} +$ $G_{44}^{(2)}\lvert(a_{44}^{''})^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a_{44}^{''})^{(9)}(T_{45}^{(2)}, s_{(44)})\rvert\ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$ Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on 45,46,47,28 and 29 it follows	
$\lvert(G_{47})^{(1)} - G^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}t} \leq$ $\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a_{44}^{'})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows	
<u>Remark 41:</u> The fact that we supposed $(a_{44}^{''})^{(9)}$ and $(b_{44}^{''})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by	

$(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ and $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i\ (t) = 0\ and\ T_i\ (t) = 0$

From 99 to 44 it results

$$G_i\ (t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i\ (t) \geq T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ and $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} and G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} or G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} is bounded, from below, the same property holds for G_{45} and G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}\ (t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}\left((G_{47})(t), t\right) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a'_{13})^{(1)} + (a'_{14})^{(1)} - (a''_{13})^{(1)}(T_{14}, t) + (a''_{14})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G, t) - (b''_{14})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)},\ if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)},\ if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)},\ if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a'_{15})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}\right] + G_{15}^0 e^{-(a'_{15})^{(1)}t}\right)$	286
$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b'_{15})^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b'_{15})^{(1)}t}\right] + T_{15}^0 e^{-(b'_{15})^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a'_{13})^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b'_{13})^{(1)}$ $(R_2)^{(1)} = (b'_{15})^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}((G_{19}), t) - (b''_{17})^{(2)}((G_{19}), t) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}(u^{(2)})^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300

roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2+(\sigma_2)^{(2)}\nu^{(2)}-(a_{16})^{(2)}=0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2+(\tau_2)^{(2)}u^{(2)}-(b_{16})^{(2)}=0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)}=(\nu_0)^{(2)}, (m_1)^{(2)}=(\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)}<(\nu_1)^{(2)}$	305
$(m_2)^{(2)}=(\nu_1)^{(2)}, (m_1)^{(2)}=(\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)}<(\nu_0)^{(2)}<(\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)}=(\nu_1)^{(2)}, (m_1)^{(2)}=(\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)}<(\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)}=(u_0)^{(2)}, (\mu_1)^{(2)}=(u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)}<(u_1)^{(2)}$ $(\mu_2)^{(2)}=(u_1)^{(2)}, (\mu_1)^{(2)}=(\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)}<(u_0)^{(2)}<(\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)}=\frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)}=(u_1)^{(2)}, (\mu_1)^{(2)}=(u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)}<(u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{16}(t) \le G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{17}(t) \le \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t}-e^{-(S_2)^{(2)}t}\right]+G_{18}^0 e^{-(S_2)^{(2)}t} \le G_{18}(t) \le\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t}-e^{-(a_{18}')^{(2)}t}\right]+G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t}-e^{-(b_{18}')^{(2)}t}\right]+T_{18}^0 e^{-(b_{18}')^{(2)}t} \le T_{18}(t) \le$	315

$\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t}-e^{-(R_2)^{(2)}t}\right]+T_{18}^0 e^{-(R_2)^{(2)}t}$	
Definition of $(S_1)^{(2)},(S_2)^{(2)},(R_1)^{(2)},(R_2)^{(2)}$:-	316
Where $(S_1)^{(2)}=(a_{16})^{(2)}(m_2)^{(2)}-(a_{16}')^{(2)}$ $(S_2)^{(2)}=(a_{18})^{(2)}-(p_{18})^{(2)}$	317
$(R_1)^{(2)}=(b_{16})^{(2)}(\mu_2)^{(1)}-(b_{16}')^{(2)}$ $(R_2)^{(2)}=(b_{18}')^{(2)}-(r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)}\le-(a_{20}')^{(3)}+(a_{21}')^{(3)}-(a_{20}'')^{(3)}(T_{21},t)+(a_{21}'')^{(3)}(T_{21},t)\le-(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)}\le-(b_{20}')^{(3)}+(b_{21}')^{(3)}-(b_{20}'')^{(3)}(G_{23},t)-(b_{21}'')^{(3)}((G_{23}),t)\le-(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)},(\nu_2)^{(3)},(u_1)^{(3)},(u_2)^{(3)}$: By $(\nu_1)^{(3)}>0,(\nu_2)^{(3)}<0$ and respectively $(u_1)^{(3)}>0,(u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_1)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_1)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$ and By $(\bar{\nu}_1)^{(3)}>0,(\bar{\nu}_2)^{(3)}<0$ and respectively $(\bar{u}_1)^{(3)}>0,(\bar{u}_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_2)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_2)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$	320
Definition of $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$ by $(m_2)^{(3)}=(\nu_0)^{(3)},(m_1)^{(3)}=(\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)}<(\nu_1)^{(3)}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\bar{\nu}_1)^{(3)},\boldsymbol{if}\ (\nu_1)^{(3)}<(\nu_0)^{(3)}<(\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)}=\frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)}<(\nu_0)^{(3)}$	321

and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}$, ***if*** $(u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}$, ***if*** $(u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}$, ***if*** $(\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ ***if*** $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, ***if*** $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ ***if*** $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ ***if*** $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, ***if*** $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)},$ ***if*** $(\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\big((G_{31}), t\big) - (b_{29}'')^{(5)}\big((G_{31}), t\big) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0, (\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0, (u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,	340

and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)}G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)}, , (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \textbf{\textit{if}}\ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \textbf{\textit{if}}\ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \textbf{\textit{if}}\ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \textbf{\textit{if}}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \textbf{\textit{if}}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \textbf{\textit{if}}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})} \left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b'_{34})^{(6)})} \left[e^{(R_1)^{(6)}t} - e^{-(b'_{34})^{(6)}t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})} \left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a'_{32})^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b'_{32})^{(6)}$ $(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$	359
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roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **<u>Definition of</u>** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
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$\left(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	
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$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
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$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$

$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if}\ (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if}\ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if}\ (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if}\ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if}\ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\left(\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq \frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}\left[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}\right] + G_{46}^0 e^{-(a_{46}')^{(9)}t}\right)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have <u>**Definition of**</u> $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain <u>**Definition of**</u> $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	386

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In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$	391
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$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$$

<u>**Definition of**</u> $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a_{20}'')^{(3)} = (a_{21}'')^{(3)}$, $then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b_{20}'')^{(3)} = (b_{21}'')^{(3)}$, $then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a_{24}')^{(4)} - (a_{25}')^{(4)} + (a_{24}'')^{(4)}(T_{25}, t)\right) - (a_{25}'')^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \le \frac{d\nu^{(4)}}{dt} \le -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \ge \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \le \nu^{(4)}(t) \le (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \le \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \le \nu^{(4)}(t) \le (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \le \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \le \nu^{(4)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \le (\bar{\nu}_1)^{(4)} \le \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \le \nu^{(4)}(t) \le \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case** .

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right) - (a_{33}'')^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)},\quad\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)},\quad\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \le \frac{d\nu^{(7)}}{dt} \le -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \ge \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \le \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \le \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \le \nu^{(7)}(t) \le$$

$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420
Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$	421

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right) t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right) t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right) t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right) t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right) t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}, \quad \boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}, \quad \boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .** Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$**, and definition of** $(u_0)^{(8)}$.	
Proof : From 99,20,44,22,23,44 we obtain $$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get $$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$ From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$	
If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case, $$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$ $$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$	

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain $(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(9)}(t)$:- $(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(9)}(t)$:- $(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$ Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem. **Particular case :** If $(a_{44}'')^{(9)} = (a_{45}'')^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case** . Analogously if $(b_{44}'')^{(9)} = (b_{45}'')^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.	
We can prove the following **Theorem** : If $(a_i'')^{(1)} and\ (b_i'')^{(1)}$ are independent on t , and the conditions with the notations $(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$ $(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}')^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$ $(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}')^{(1)}(r_{14})^{(1)} - (b_{14}')^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	425
Theorem : If $(a_i'')^{(2)} and\ (b_i'')^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}')^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429

$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

with $(p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ *with* $(p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ *with* $(p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ *with* $(p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\,]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (m) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}')^{(4)}(a_{25}'')^{(4)}(T_{25}) + (a_{25}')^{(4)}(a_{24}'')^{(4)}(T_{25}) + (a_{24}'')^{(4)}(T_{25})(a_{25}'')^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}')^{(5)}(a_{29}'')^{(5)}(T_{29}) + (a_{29}')^{(5)}(a_{28}'')^{(5)}(T_{29}) + (a_{28}'')^{(5)}(T_{29})(a_{29}'')^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}')^{(6)}(a_{33}'')^{(6)}(T_{33}) + (a_{33}')^{(6)}(a_{32}'')^{(6)}(T_{33}) + (a_{32}'')^{(6)}(T_{33})(a_{33}'')^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}')^{(7)}(a_{37}'')^{(7)}(T_{37}) + (a_{37}')^{(7)}(a_{36}'')^{(7)}(T_{37}) + (a_{36}'')^{(7)}(T_{37})(a_{37}'')^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}')^{(8)}(a_{41}'')^{(8)}(T_{41}) + (a_{41}')^{(8)}(a_{40}'')^{(8)}(T_{41}) + (a_{40}'')^{(8)}(T_{41})(a_{41}'')^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}')^{(9)}(a_{45}'')^{(9)}(T_{45}) + (a_{45}')^{(9)}(a_{44}'')^{(9)}(T_{45}) + (a_{44}'')^{(9)}(T_{45})(a_{45}'')^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T_{14}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^* for which $f(T_{14}^*) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^*)]}$	493
Definition and uniqueness of T_{17}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)} G_{17}}{[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)} G_{17}}{[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$	499
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right]+(b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
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By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi({G_{35}}^*) = 0$	508
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By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi({G_{43}}^*) = 0$	510
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Where in $(G_{47})(G_{44},G_{45},G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*)=0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*)=0$, T_{14}^* given by $f(T_{14}^*)=0$ and $G_{13}^*=\frac{(a_{13})^{(1)}G_{14}^*}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^*=\frac{(a_{15})^{(1)}G_{14}^*}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^*=\frac{(b_{13})^{(1)}T_{14}^*}{[(b_{13}')^{(1)}-(b_{13}'')^{(1)}(G^*)]}$, $T_{15}^*=\frac{(b_{15})^{(1)}T_{14}^*}{[(b_{15}')^{(1)}-(b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*)=0$, T_{17}^* given by $f(T_{17}^*)=0$ and	512
$G_{16}^*=\frac{(a_{16})^{(2)}G_{17}^*}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^*=\frac{(a_{18})^{(2)}G_{17}^*}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^*=\frac{(b_{16})^{(2)}T_{17}^*}{[(b_{16}')^{(2)}-(b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^*=\frac{(b_{18})^{(2)}T_{17}^*}{[(b_{18}')^{(2)}-(b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*)=0$, T_{21}^* given by $f(T_{21}^*)=0$ and $G_{20}^*=\frac{(a_{20})^{(3)}G_{21}^*}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^*=\frac{(a_{22})^{(3)}G_{21}^*}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^*=\frac{(b_{20})^{(3)}T_{21}^*}{[(b_{20}')^{(3)}-(b_{20}'')^{(3)}(G_{23}{}^*)]}$, $T_{22}^*=\frac{(b_{22})^{(3)}T_{21}^*}{[(b_{22}')^{(3)}-(b_{22}'')^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^*=\frac{(a_{24})^{(4)}G_{25}^*}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^*=\frac{(a_{26})^{(4)}G_{25}^*}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^*=\frac{(b_{24})^{(4)}T_{25}^*}{[(b_{24}')^{(4)}-(b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^*=\frac{(b_{26})^{(4)}T_{25}^*}{[(b_{26}')^{(4)}-(b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)}T_{45}^*}{[(b_{44}')^{(9)}-(b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)}T_{45}^*}{[(b_{46}')^{(9)}-(b_{46}'')^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)}G_{13}^*\mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)}G_{14}^*\mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)}G_{15}^*\mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)}T_{13}^*\mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)}T_{14}^*\mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)}T_{15}^*\mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial(b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*}) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$

$\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$

Then taking into account equations and neglecting the terms of power 2, we obtain

$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)} G_{24}^* \mathbb{T}_{25}$ 549

$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)} G_{25}^* \mathbb{T}_{25}$ 550

$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)} G_{26}^* \mathbb{T}_{25}$ 551

$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)} T_{24}^* \mathbb{G}_j\right)$ 552

$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)} T_{25}^* \mathbb{G}_j\right)$ 553

$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)} T_{26}^* \mathbb{G}_j\right)$ 554

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Theorem 5: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- 556

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$

$\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$

Then taking into account equations and neglecting the terms of power 2, we obtain

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)} G_{28}^* \mathbb{T}_{29}$ 557

$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)} G_{29}^* \mathbb{T}_{29}$ 558

$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)} G_{30}^* \mathbb{T}_{29}$ 559

$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)} T_{28}^* \mathbb{G}_j\right)$ 560

$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)} T_{29}^* \mathbb{G}_j\right)$ 561

$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)} T_{30}^* \mathbb{G}_j\right)$ 562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G_{38}^{*}\mathbb{T}_{37}$ 575

$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T_{36}^{*}\mathbb{G}_{j}\right)$ 576

$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T_{37}^{*}\mathbb{G}_{j}\right)$ 578

$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T_{38}^{*}\mathbb{G}_{j}\right)$ 579

Obviously, these values represent an equilibrium solution

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Theorem 8: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- 580

$$G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$$

$$\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^{*}) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*}\right) = s_{ij}$$

Then taking into account equations and neglecting the terms of power 2, we obtain

$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G_{40}^{*}\mathbb{T}_{41}$ 581

$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G_{41}^{*}\mathbb{T}_{41}$ 582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)} G_{42}^{*}\mathbb{T}_{41}$ 583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}')^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)} T_{40}^{*}\mathbb{G}_{j}\right)$ 584

$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}')^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)} T_{41}^{*}\mathbb{G}_{j}\right)$ 585

$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}')^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)} T_{42}^{*}\mathbb{G}_{j}\right)$ 586

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Theorem 9: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(9)}$ *and* $(b_i'')^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{45})^{(9)}}{\partial T_{45}} (T_{45}^*) = (q_{45})^{(9)} \;,\; \frac{\partial (b''_i)^{(9)}}{\partial G_j} ((G_{47})^*) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a'_{44})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)} G_{44}^* \mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a'_{45})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)} G_{45}^* \mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a'_{46})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)} G_{46}^* \mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b'_{44})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)} T_{44}^* \mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b'_{45})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)} T_{45}^* \mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b'_{46})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)} T_{46}^* \mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b'_{15})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a'_{15})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)} G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right) s_{(14),(14)} T_{14}^* + (b_{14})^{(1)} s_{(13),(14)} T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a'_{14})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)} G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)} G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right) s_{(14),(13)} T_{14}^* + (b_{14})^{(1)} s_{(13),(13)} T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b'_{13})^{(1)} + (b'_{14})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)(q_{15})^{(1)} G_{15}$ $+\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right) \left((a_{15})^{(1)}(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)} G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right) s_{(14),(15)} T_{14}^* + (b_{14})^{(1)} s_{(13),(15)} T_{13}^*\right)\} = 0$ +	

$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$

$+\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$

$+$

$((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(((\lambda)^{(4)})^{2}+((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^{2}+((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)})(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^{2}+((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(((\lambda)^{(5)})^{2}+((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^{2}+((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)})(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^{2}+((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$ +	

$((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)})\{((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)})$

$\left[\left(((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)})(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$

$\left(((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)})s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$

$+\left(((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)})(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$

$\left(((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)})s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$

$\left(((\lambda)^{(6)})^{2}+((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)})(\lambda)^{(6)}\right)$

$\left(((\lambda)^{(6)})^{2}+((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)})(\lambda)^{(6)}\right)$

$+\left(((\lambda)^{(6)})^{2}+((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)})(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$

$+((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)})\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$

$\left(((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)})s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$

$+$

$((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)})\{((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)})$

$\left[\left(((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)})(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$

$\left(((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)})s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$

$+\left(((\lambda)^{(7)}+(a_{37}')^{(7)}+(p_{37})^{(7)})(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$

$\left(((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)})s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$

$\left(((\lambda)^{(7)})^{2}+((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)})(\lambda)^{(7)}\right)$

$\left(((\lambda)^{(7)})^{2}+((b_{36}')^{(7)}+(b_{37}')^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)})(\lambda)^{(7)}\right)$

$+\left(((\lambda)^{(7)})^{2}+((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)})(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$

$+((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)})\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$

$\left(((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)})s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$

$+$

$((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)})$

$\left[\left(((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(((\lambda)^{(8)})^{2} + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$

$\left(((\lambda)^{(8)})^{2} + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$

$+\left(((\lambda)^{(8)})^{2} + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$

$+$

$((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)})$

$\left[\left(((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(((\lambda)^{(9)})^{2} + \left((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)$

$\left(((\lambda)^{(9)})^{2} + \left((b_{44}^{'})^{(9)} + (b_{45}^{'})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right) (\lambda)^{(9)}\right)$

$+\left(((\lambda)^{(9)})^{2} + \left((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\} = 0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.	

SECTION FOURTEEN

Hydrodynamics On The Lowest Landau Level

INTRODUCTION—VARIABLES USED

Hydrodynamics on the lowest Landau level Michael Geracie, Dam Thanh Son

(1) Using the recently developed approach to quantum Hall physics based on (e) Newton-Cartan geometry, authors consider the hydrodynamics of (e) an interacting system on (eb) the lowest Landau level.
(2) Authors rephrase the non-relativistic fluid equations of motion in a manner that manifests (eb) the spacetime diffeomorphism invariance of (e) the underlying theory.
(3) In the massless (or lowest Landau level) limit, the fluid obeys (e&eb) a force-free constraint which fixes (e&eb) the charge current.
(4) An entropy current analysis further constrains (e) the energy response, determining (eb) four transverse response functions in terms of (e&eb) only two: an energy magnetization and (e&eb) a thermal Hall conductivity.
(5) Kubo formulas are presented for (e) all transport coefficients and constraints from (e) Weyl invariance derived.
(6) Authors also present a number of Streda-type formulas for (e) the equilibrium response to (e&eb) external electric, magnetic and gravitational fields. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); High Energy Physics - Theory (hep-th) Cite as: arXiv: 1408.6843 [cond-mat.mes-hall] (or arXiv: 1408.6843v1 [cond-mat.mes-hall] for this version)

Fields and fluids on curved non-relativistic spacetimes Michael Geracie, Kartik Prabhu, Matthew M. Roberts

(7) Authors consider non-relativistic curved geometries and argue that the background structure should be generalized from (e) that considered in previous works
(8) In this approach the derivative operator is defined by (e) a Galilean spin connection valued in the Lie algebra of the Galilean group.
(9) This includes (e) the usual spin connection plus an additional "boost connection" which parameterizes (e&eb) the freedom in the derivative operator not fixed by (e) torsion or metric compatibility.
(10) As an example authors write down the most general theory of dissipative fluids consistent with (e&eb) the second law in curved non-relativistic geometries and find (eb) significant differences in the allowed transport coefficients from (e) those found previously
(11). Kubo formulas for all response coefficients are presented. Approach also immediately generalizes

(eb) to systems with (e&eb) independent mass and charge currents as would arise (eb) in multicomponent fluids. **(12)** Along the way authors also discuss how to write general locally Galilean invariant non-relativistic actions for (e) multiple particle species at any order in derivatives. A detailed review of the geometry and its relation to (e&eb) non-relativistic limits may be found in a companion paper [arXiv: 1503.02682]. Subjects: High Energy Physics - Theory (hep-th); Mesoscale and Nanoscale Physics (cond-mat.mes-hall) journal reference: JHEP 08 (2015) 042 DOI: 10.1007/JHEP08 (2015)042 Report number: EFI-15-13 Cite as: arXiv:1503.02680 [hep-th] (or arXiv:1503.02680v6 [hep-th] for this version)	
NOTATION	
Module One Using the recently developed approach to quantum Hall physics based on (e) Newton-Cartan geometry, authors consider the hydrodynamics of (e) an interacting system on (eb) the lowest Landau level	
G_{13} : Category one of Newton-Cartan geometry, authors consider the hydrodynamics of (e) an interacting system on (eb) the lowest Landau level G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of approach to quantum Hall physics T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two Using the recently developed approach to quantum Hall physics based on Newton-Cartan geometry, authors consider the hydrodynamics of (e) an interacting system on (eb) the lowest Landau level	
G_{16} : Category one of approach to quantum Hall physics based on Newton-Cartan geometry, authors consider the hydrodynamics; **interacting system on (eb) the lowest Landau level** G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of **interacting system on (eb) the lowest Landau level** ;approach to quantum Hall physics based on Newton-Cartan geometry, authors consider the hydrodynamics T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three Using the recently developed approach to quantum Hall physics based on Newton-Cartan geometry, authors consider the hydrodynamics of an interacting system on (eb) the lowest Landau level In cases where classification is not possible, take all the three categories as equivalent.	

G_{20} : Category one of **approach to quantum Hall physics based on Newton-Cartan geometry, authors consider the hydrodynamics of an interacting system;** lowest Landau level G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of lowest Landau level; **approach to quantum Hall physics based on Newton-Cartan geometry, authors consider the hydrodynamics of an interacting system** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Authors rephrase the non-relativistic fluid equations of motion in a manner that manifests (eb) the spacetime diffeomorphism invariance of (e) the underlying theory	
G_{24} : Category one of **non-relativistic fluid equations of motion;** spacetime diffeomorphism invariance of the underlying theory G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of spacetime diffeomorphism invariance of the underlying theory **; non-relativistic fluid equations of motion** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five the fluid in the massless (or lowest Landau level) limit obeys (e&eb) a force-free constraint which fixes (e&eb) the charge current	
G_{28} : Category one of **fluid in the massless (or lowest Landau level) limit;** force-free constraint which fixes (e&eb) the charge current G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of force-free constraint which fixes (e&eb) the charge current **;fluid in the massless (or lowest Landau level) limit** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six the fluid in the massless (or lowest Landau level) limit obeys a force-free constraint which fixes (e&eb) the	

charge current	
G_{32} : Category one of **fluid in the massless (or lowest Landau level) limit obeys a force-free constraint;** charge current G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of charge current **; fluid in the massless (or lowest Landau level) limit obeys a force-free constraint** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven An entropy current analysis further constrains (e) the energy response, determining (eb) four transverse response functions in terms of (e&eb) only two: an energy magnetization and (e&eb) a thermal Hall conductivity	
G_{36} : Category one of **entropy current analysis;** energy response, determining (eb) four transverse response functions in terms of (e&eb) only two: an energy magnetization and (e&eb) a thermal Hall conductivity G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of energy response, determining (eb) four transverse response functions in terms of (e&eb) only two: an energy magnetization and (e&eb) a thermal Hall conductivity **;entropy current analysis** T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight An entropy current analysis further constrains the energy response, determining (eb) four transverse response functions in terms of (e&eb) only two: an energy magnetization and (e&eb) a thermal Hall conductivity	
G_{40} : Category one of entropy current analysis further constrains the energy response G_{41} : Category two of SAS G_{42} : Category three of SAS	

T_{40} : Category one of four transverse response functions in terms of (e&eb) only two: an energy magnetization and (e&eb) a thermal Hall conductivity T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine An entropy current analysis further constrains the energy response, determining four transverse response functions in terms of (e&eb) only two: an energy magnetization and (e&eb) a thermal Hall conductivity	
G_{44} : Category one of **entropy current analysis further constrains the energy response, determining four transverse response functions;** only two: an energy magnetization and (e&eb) a thermal Hall conductivity G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of only two: an energy magnetization and (e&eb) a thermal Hall conductivity; **entropy current analysis further constrains the energy response, determining four transverse response functions** T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	

Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt}=(a_{13})^{(1)}G_{14}-\left[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt}=(a_{14})^{(1)}G_{13}-\left[(a_{14}^{'})^{(1)}+(a_{14}^{''})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\left[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\left[(b_{13}^{'})^{(1)}-(b_{13}^{''})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[(b_{14}^{'})^{(1)}-(b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[(b_{15}^{'})^{(1)}-(b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t)=$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t)=$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[(a_{17}^{'})^{(2)}+(a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[(b_{16}^{'})^{(2)}-(b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[(b_{17}^{'})^{(2)}-(b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[(b_{18}^{'})^{(2)}-(b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t)=$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right)=$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\left[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt}=(a_{21})^{(3)}G_{20}-\left[(a_{21}^{'})^{(3)}+(a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt}=(a_{22})^{(3)}G_{21}-\left[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt}=(b_{20})^{(3)}T_{21}-\left[(b_{20}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt}=(b_{21})^{(3)}T_{20}-\left[(b_{21}^{'})^{(3)}-(b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt}=(b_{22})^{(3)}T_{21}-\left[(b_{22}^{'})^{(3)}-(b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t)=$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t)=$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\left[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19

$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}')^{(4)} - (b_{26}'')^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}'')^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}')^{(5)} - (b_{28}'')^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}')^{(5)} - (b_{29}'')^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}')^{(5)} - (b_{30}'')^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}'')^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}'')^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}')^{(6)} - (b_{32}'')^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}')^{(6)} - (b_{33}'')^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}')^{(6)} - (b_{34}'')^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}'')^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b_{36}')^{(7)} - (b_{36}'')^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b_{37}')^{(7)} - (b_{37}'')^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*

$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)} \left((G_{39}), t \right) \right] T_{38}$	*42*
$+(a''_{36})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41}, t) \right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}, t) \right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}, t) \right] G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)} \left((G_{43}), t \right) \right] T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)} \left((G_{43}), t \right) \right] T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)} \left((G_{43}), t \right) \right] T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)} \left((G_{47}), t \right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)} \left((G_{47}), t \right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)} \left((G_{47}), t \right) \right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}), t \right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14}, t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{40})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{13}$	*55*
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14}, t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{41})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{14}$	*56*
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14}, t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{42})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{15}$	*57*
Where $\boxed{(a''_{13})^{(1)}(T_{14}, t)}$, $\boxed{(a''_{14})^{(1)}(T_{14}, t)}$, $\boxed{(a''_{15})^{(1)}(T_{14}, t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17}, t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21}, t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21}, t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21}, t)}$ are third augmentation coefficient for category 1, 2 and 3	

$+(a''_{24})^{(4,4,4,4,)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{38})^{(7,7)}(T_{37},t)$ $+(a''_{37})^{(7,7)}(T_{37},t)$ $+(a''_{36})^{(7,7)}(T_{37},t)$ are seventh augmentation coefficient for 1,2,3 $+(a''_{40})^{(8,8)}(T_{41},t)$ $+(a''_{41})^{(8,8)}(T_{41},t)$ $+(a''_{42})^{(8,8)}(T_{41},t)$ are eight augmentation coefficient for 1,2,3 $+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	*60*
Where $-(b''_{13})^{(1)}(G,t)$, $-(b''_{14})^{(1)}(G,t)$, $-(b''_{15})^{(1)}(G,t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{16})^{(2,2,)}(G_{19},t)$, $-(b''_{17})^{(2,2,)}(G_{19},t)$, $-(b''_{18})^{(2,2,)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3 $-(b''_{20})^{(3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{37})^{(7,7,)}(G_{39},t)$, $-(b''_{36})^{(7,7,)}(G_{39},t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8)}(G_{43},t)$ $-(b''_{41})^{(8,8)}(G_{43},t)$ $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{array}{c} (a'_{16})^{(2)}\boxed{+(a''_{16})^{(2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{array}\right] G_{16} \quad 61$$

$$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{array}{c} (a'_{17})^{(2)}\boxed{+(a''_{17})^{(2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{array}\right] G_{17} \quad 62$$

$$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{array}{c} (a'_{18})^{(2)}\boxed{+(a''_{18})^{(2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{array}\right] G_{18} \quad 63$$

Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{array}{c} (b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,)}(G,t)}\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{array}\right] T_{16} \quad 64$$

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{array}{c} (b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,)}(G,t)}\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{array}\right] T_{17} \quad 65$$

$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$,$\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)}\boxed{-(b''_{20})^{(3)}(G_{23},t)}\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)}\boxed{-(b''_{21})^{(3)}(G_{23},t)}\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)}\boxed{-(b''_{22})^{(3)}(G_{23},t)}\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$,$\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$,$\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\left[\begin{matrix}(a'_{24})^{(4)}+(a''_{24})^{(4)}(T_{25},t)+(a''_{28})^{(5,5,)}(T_{29},t)+(a''_{32})^{(6,6,)}(T_{33},t)\\+(a''_{13})^{(1,1,1,1)}(T_{14},t)+(a''_{16})^{(2,2,2,2)}(T_{17},t)+(a''_{20})^{(3,3,3,3)}(T_{21},t)\\+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)+(a''_{44})^{(9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{24}$	73
$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\left[\begin{matrix}(a'_{25})^{(4)}+(a''_{25})^{(4)}(T_{25},t)+(a''_{29})^{(5,5,)}(T_{29},t)+(a''_{33})^{(6,6)}(T_{33},t)\\+(a''_{14})^{(1,1,1,1)}(T_{14},t)+(a''_{17})^{(2,2,2,2)}(T_{17},t)+(a''_{21})^{(3,3,3,3)}(T_{21},t)\\+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)+(a''_{45})^{(9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{25}$	74
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\left[\begin{matrix}(a'_{26})^{(4)}+(a''_{26})^{(4)}(T_{25},t)+(a''_{30})^{(5,5,)}(T_{29},t)+(a''_{34})^{(6,6,)}(T_{33},t)\\+(a''_{15})^{(1,1,1,1)}(T_{14},t)+(a''_{18})^{(2,2,2,2)}(T_{17},t)+(a''_{22})^{(3,3,3,3)}(T_{21},t)\\+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)+(a''_{46})^{(9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{26}$	75
$(a''_{24})^{(4)}(T_{25},t)$, $(a''_{25})^{(4)}(T_{25},t)$, $(a''_{26})^{(4)}(T_{25},t)$ *are first augmentation coefficients category* 1, 2 3 $+(a''_{28})^{(5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{32})^{(6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{13})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1)}(T_{14},t)$ *are fourth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{16})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2)}(T_{17},t)$ *are fifth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{20})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3)}(T_{21},t)$ *are sixth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$ *are seventh augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)$ *are eighth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{46})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9)}(T_{45},t)$ are ninth detrition coefficients for category 1 2 3	
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[\begin{matrix}(b'_{24})^{(4)}-(b''_{24})^{(4)}(G_{27},t)-(b''_{28})^{(5,5,)}(G_{31},t)-(b''_{32})^{(6,6,)}(G_{35},t)\\-(b''_{13})^{(1,1,1,1)}(G,t)-(b''_{16})^{(2,2,2,2)}(G_{19},t)-(b''_{20})^{(3,3,3,3)}(G_{23},t)\\-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)-(b''_{44})^{(9,9,9,9)}(G_{47},t)\end{matrix}\right]T_{24}$	76
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\left[\begin{matrix}(b'_{25})^{(4)}-(b''_{25})^{(4)}(G_{27},t)-(b''_{29})^{(5,5,)}(G_{31},t)-(b''_{33})^{(6,6,)}(G_{35},t)\\-(b''_{14})^{(1,1,1,1)}(G,t)-(b''_{17})^{(2,2,2,2)}(G_{19},t)-(b''_{21})^{(3,3,3,3)}(G_{23},t)\\-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)-(b''_{45})^{(9,9,9,9)}(G_{47},t)\end{matrix}\right]T_{25}$	77

$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3	

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28} \quad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30} \quad 84$$

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{32} \qquad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)}\boxed{+(a''_{33})^{(6)}(T_{33},t)}\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{33} \qquad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)}\boxed{+(a''_{34})^{(6)}(T_{33},t)}\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{34} \qquad 87$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right]T_{32} \qquad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{33}$$ 89

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{34}$$ 90

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$$ 91

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$$ 92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[\begin{matrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} & \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} & \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15} \qquad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13} \qquad 94$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} =$$

$$(b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b'_{44})^{(9)}\boxed{-(b''_{44})^{(9)}(G_{47},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b'_{45})^{(9)}\boxed{-(b''_{45})^{(9)}(G_{47},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)}\boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
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Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \ ,\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
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satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i')^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i')^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0, \quad i,j=16,17,18$	
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Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)} + (a_i')^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i')^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}] < 1$	111
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Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)},$ are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}\ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
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$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. <u>Definition of</u> $(p_i)^{(4)}, \ (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25}, t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}), t) \leq \ (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'}, t)$ and $(a_i^{''})^{(4)}(T_{25}, t)$. $(T_{25}^{'}, t)$ and (T_{25}, t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} \ , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i^{'})^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)} (\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i^{'})^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)} (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29}, t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}), t) \leq (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	122
$lim_{T_2 \to \infty} (a_i^{''})^{(5)} (T_{29}, t) = (p_i)^{(5)}$ $\lim_{G \to \infty} (b_i^{''})^{(5)} (G_{31}, t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'}, t)$ and $(a_i^{''})^{(5)}(T_{29}, t)$. $(T_{29}^{'}, t)$ and (T_{29}, t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}$, $\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
<u>**Definition of**</u> $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)}$ *and* $(\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i^{'})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i^{'})^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i^{'})^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i^{'})^{(6)}, (a_i^{''})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (b_i^{''})^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i^{''})^{(6)}, (b_i^{''})^{(6)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i^{''})^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i^{''})^{(6)}((G_{35}), t) \leq (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
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They satisfy Lipschitz condition: $\|(a_i^{''})^{(6)}(T_{33}^{'}, t) - (a_i^{''})^{(6)}(T_{33}, t)\| \leq (\hat{k}_{32})^{(6)} \|T_{33} - T_{33}^{'}\| e^{-(\hat{M}_{32})^{(6)} t}$ $\|(b_i^{''})^{(6)}((G_{35})^{'}, t) - (b_i^{''})^{(6)}((G_{35}), t)\| < (\hat{k}_{32})^{(6)} \|\|(G_{35}) - (G_{35})^{'}\|\| e^{-(\hat{M}_{32})^{(6)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'}, t)$ and $(a_i^{''})^{(6)}(T_{33}, t)$. $(T_{33}^{'}, t)$ and (T_{33}, t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants	129

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(AAAA) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (BBBB) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \le (p_i)^{(7)} \le (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \le (r_i)^{(7)} \le (b_i')^{(7)} \le (\hat{B}_{36})^{(7)}$	131
(CCCC) $\lim_{T_2 \to \infty} (a_i'')^{(7)}(T_{37}, t) = (p_i)^{(7)}$ *(DDDD)* $\lim_{G \to \infty} (b_i'')^{(7)}((G_{39}), t) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\|(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\| \le (\hat{k}_{36})^{(7)} \|T_{37} - T_{37}'\| e^{-(\hat{M}_{36})^{(7)} t}$ $\|(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\| < (\hat{k}_{36})^{(7)} \|\|(G_{39}) - (G_{39})'\|\| e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (EEEE) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}$, $\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (FFFF) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i^{'})^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i^{'})^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i^{'})^{(8)}, (a_i^{''})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (b_i^{''})^{(8)} > 0, \quad i, j = 40,41,42$	136
The functions $(a_i^{''})^{(8)}, (b_i^{''})^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i^{''})^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i^{''})^{(8)}((G_{43}), t) \leq (r_i)^{(8)} \leq (b_i^{'})^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2 \to \infty} (a_i^{''})^{(8)} (T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G \to \infty} (b_i^{''})^{(8)} \left((G_{43}), t\right) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'}, t) - (a_i^{''})^{(8)}(T_{41}, t)\rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}^{'}\rvert e^{-(\hat{M}_{40})^{(8)} t}$	142

$\lvert(b_i^{''})^{(8)}((G_{43})',t)-(b_i^{''})^{(8)}((G_{43}),t)\rvert<(\hat{k}_{40})^{(8)}\lvert\lvert(G_{43})-(G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}',t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)}=1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}<1$	144
Definition of $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)}, (r_i)^{(8)}, i=40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i')^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i^{''})^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i^{''})^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i^{''})^{(9)},(b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t)\le(p_i)^{(9)}\le(\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t)\le (r_i)^{(9)}\le(b_i')^{(9)}\le(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i^{''})^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i^{''})^{(9)}(G_{47},t)= (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition:	

$$|(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)|\le(\hat{k}_{44})^{(9)}|T_{45}-T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)|<(\hat{k}_{44})^{(9)}||(G_{47})-(G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and$(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ ,\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$$

Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(p_i)^{(9)},\ (r_i)^{(9)},i=44,45,46,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i')^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i')^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0),T_i(0)$:

$$G_i(t)\le(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}\ ,\quad \boxed{G_i(0)=G_i^0>0}$$

$$T_i(t)\le(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}\ ,\quad \boxed{T_i(0)=T_i^0>0}$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0),T_i(0)$

$$G_i(t)\le(\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}\ ,\quad G_i(0)=G_i^0>0$$

$$T_i(t)\le(\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}\ ,\quad T_i(0)=T_i^0>0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t)\le(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}\ ,\quad G_i(0)=G_i^0>0$$

$T_i(t) \leq \left(\hat{Q}_{20} \right)^{(3)} e^{\left(\hat{M}_{20} \right)^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24} \right)^{(4)} e^{\left(\hat{M}_{24} \right)^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{24} \right)^{(4)} e^{\left(\hat{M}_{24} \right)^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28} \right)^{(5)} e^{\left(\hat{M}_{28} \right)^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{28} \right)^{(5)} e^{\left(\hat{M}_{28} \right)^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32} \right)^{(6)} e^{\left(\hat{M}_{32} \right)^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{32} \right)^{(6)} e^{\left(\hat{M}_{32} \right)^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{\left(\hat{M}_{36} \right)^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{36} \right)^{(7)} e^{\left(\hat{M}_{36} \right)^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{\left(\hat{M}_{40} \right)^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{40} \right)^{(8)} e^{\left(\hat{M}_{40} \right)^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{13})^{(1)} , T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}')^{(1)} - (b_{13}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}')^{(1)} - (b_{14}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}')^{(1)} - (b_{15}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{16})^{(2)} , T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}')^{(2)} + a_{16}'')^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{16}(s_{(16)}) \right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}')^{(2)} + (a_{17}'')^{(2)} (T_{17}(s_{(16)}), s_{(17)}) \right) G_{17}(s_{(16)}) \right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \Big[(a_{18})^{(2)} G_{17}\big(s_{(16)}\big) - \Big((a_{18}')^{(2)} + (a_{18}'')^{(2)}\big(T_{17}\big(s_{(16)}\big), s_{(16)}\big)\Big) G_{18}\big(s_{(16)}\big)\Big] \, ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \Big[(b_{16})^{(2)} T_{17}\big(s_{(16)}\big) - \Big((b_{16}')^{(2)} - (b_{16}'')^{(2)}\big(G_{19}\big(s_{(16)}\big), s_{(16)}\big)\Big) T_{16}\big(s_{(16)}\big)\Big] \, ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \Big[(b_{17})^{(2)} T_{16}\big(s_{(16)}\big) - \Big((b_{17}')^{(2)} - (b_{17}'')^{(2)}\big(G_{19}\big(s_{(16)}\big), s_{(16)}\big)\Big) T_{17}\big(s_{(16)}\big)\Big] \, ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \Big[(b_{18})^{(2)} T_{17}\big(s_{(16)}\big) - \Big((b_{18}')^{(2)} - (b_{18}'')^{(2)}\big(G_{19}\big(s_{(16)}\big), s_{(16)}\big)\Big) T_{18}\big(s_{(16)}\big)\Big] \, ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \Big[(a_{20})^{(3)} G_{21}\big(s_{(20)}\big) - \Big((a_{20}')^{(3)} + a_{20}'')^{(3)}\big(T_{21}\big(s_{(20)}\big), s_{(20)}\big)\Big) G_{20}\big(s_{(20)}\big)\Big] \, ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \Big[(a_{21})^{(3)} G_{20}\big(s_{(20)}\big) - \Big((a_{21}')^{(3)} + (a_{21}'')^{(3)}\big(T_{21}\big(s_{(20)}\big), s_{(20)}\big)\Big) G_{21}\big(s_{(20)}\big)\Big] \, ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \Big[(a_{22})^{(3)} G_{21}\big(s_{(20)}\big) - \Big((a_{22}')^{(3)} + (a_{22}'')^{(3)}\big(T_{21}\big(s_{(20)}\big), s_{(20)}\big)\Big) G_{22}\big(s_{(20)}\big)\Big] \, ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \Big[(b_{20})^{(3)} T_{21}\big(s_{(20)}\big) - \Big((b_{20}')^{(3)} - (b_{20}'')^{(3)}\big(G_{23}\big(s_{(20)}\big), s_{(20)}\big)\Big) T_{20}\big(s_{(20)}\big)\Big] \, ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \Big[(b_{21})^{(3)} T_{20}\big(s_{(20)}\big) - \Big((b_{21}')^{(3)} - (b_{21}'')^{(3)}\big(G_{23}\big(s_{(20)}\big), s_{(20)}\big)\Big) T_{21}\big(s_{(20)}\big)\Big] \, ds_{(20)}$	
$\bar{\mathrm{T}}_{22}(\mathrm{t}) = \mathrm{T}_{22}^0 + \int_0^t \Big[(b_{22})^{(3)} T_{21}\big(s_{(20)}\big) - \Big((b_{22}')^{(3)} - (b_{22}'')^{(3)}\big(G_{23}\big(s_{(20)}\big), s_{(20)}\big)\Big) T_{22}\big(s_{(20)}\big)\Big] \, ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{\mathrm{T}}_{26}(\mathrm{t}) = \mathrm{T}_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\hat{P}_{32})^{(6)} \,, T_i^0 \leq (\hat{Q}_{32})^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a'_{32})^{(6)} + a''_{32})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a'_{33})^{(6)} + (a''_{33})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a'_{34})^{(6)} + (a''_{34})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b'_{32})^{(6)} - (b''_{32})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\hat{P}_{36})^{(7)} \,, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}')^{(9)} + a_{44}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}')^{(9)} - (b_{44}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}')^{(9)} - (b_{45}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}')^{(9)} - (b_{46}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[((\hat{P}_{13})^{(1)} + G_{14}^0) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $(1 + (a_{16})^{(2)} t) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[((\hat{P}_{16})^{(2)} + G_{17}^0) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0) e^{-(\hat{M}_{24})^{(4)} t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left[\left((\hat{P}_{24})^{(4)} + G_{25}^0 \right) e^{\left(-\frac{(\hat{P}_{24})^{(4)} + G_{25}^0}{G_{25}^0} \right)} + (\hat{P}_{24})^{(4)} \right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176

From which it follows that $(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(n) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0+\int_0^t\left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right]ds_{(36)} =$ $\left(1+(a_{36})^{(7)}t\right)G_{37}^0+\frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$	178
From which it follows that $(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0+\int_0^t\left[(a_{40})^{(8)}\left(G_{41}^0+(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right]ds_{(40)} =$ $\left(1+(a_{40})^{(8)}t\right)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	180
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0+\int_0^t\left[(a_{44})^{(9)}\left(G_{45}^0+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right]ds_{(44)} =$ $\left(1+(a_{44})^{(9)}t\right)G_{45}^0+\frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$	
From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$	

(G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for $G_{45}, G_{46}, T_{44}, T_{45}, T_{46}$	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\mathcal{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\mathcal{M}_{13})^{(1)}} < 1$ and to choose $(\widehat{P}_{13})^{(1)}$ and $(\widehat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\widehat{M}_{13})^{(1)}}\left[(\widehat{P}_{13})^{(1)} + ((\widehat{P}_{13})^{(1)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\widehat{M}_{13})^{(1)}}\left[((\widehat{Q}_{13})^{(1)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{13})^{(1)}\right] \leq (\widehat{Q}_{13})^{(1)}$	184
In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left((G^{(1)}, T^{(1)}), (G^{(2)}, T^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\widehat{M}_{13})^{(1)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\widehat{M}_{13})^{(1)}t}\}$	185
Indeed if we denote **Definition of** $\tilde{G}, \tilde{T}$: $(\tilde{G}, \tilde{T}) = \mathcal{A}^{(1)}(G, T)$ It results $\lvert\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{13})^{(1)} \lvert G_{14}^{(1)} - G_{14}^{(2)}\rvert e^{-(\widehat{M}_{13})^{(1)}s_{(13)}} e^{(\widehat{M}_{13})^{(1)}s_{(13)}}\, ds_{(13)} +$ $\int_0^t \{(a'_{13})^{(1)} \lvert G_{13}^{(1)} - G_{13}^{(2)}\rvert e^{-(\widehat{M}_{13})^{(1)}s_{(13)}} e^{-(\widehat{M}_{13})^{(1)}s_{(13)}} +$ $(a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) \lvert G_{13}^{(1)} - G_{13}^{(2)}\rvert e^{-(\widehat{M}_{13})^{(1)}s_{(13)}} e^{(\widehat{M}_{13})^{(1)}s_{(13)}} +$ $G_{13}^{(2)} \lvert (a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) - (a''_{13})^{(1)}(T_{14}^{(2)}, s_{(13)})\rvert\; e^{-(\widehat{M}_{13})^{(1)}s_{(13)}} e^{(\widehat{M}_{13})^{(1)}s_{(13)}}\} ds_{(13)}$ Where $s_{(13)}$ represents integrand that is integrated over the interval [0, t] From the hypotheses it follows	
$\lvert G^{(1)} - G^{(2)}\rvert e^{-(\widehat{M}_{13})^{(1)}t} \leq$ $\frac{1}{(\widehat{M}_{13})^{(1)}}\left((a_{13})^{(1)} + (a'_{13})^{(1)} + (\widehat{A}_{13})^{(1)} + (\widehat{P}_{13})^{(1)}(\widehat{k}_{13})^{(1)}\right) d\left((G^{(1)}, T^{(1)};\; G^{(2)}, T^{(2)})\right)$	186

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	
Remark 1: The fact that we supposed $(a''_{13})^{(1)}$ and $(b''_{13})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$ *and* $(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(1)}$ and $(b''_i)^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 2: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ From 19 to 24 it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(1)} - (a''_i)^{(1)}(T_{14}(s_{(13)}), s_{(13)})\} ds_{(13)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b'_i)^{(1)}t)} > 0$ for t > 0	
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<u>Remark 36:</u> The fact that we supposed $(a''_{40})^{(8)}$ and $(b''_{40})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ *and* $(\widehat{Q}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(8)}$ and $(b''_i)^{(8)}, i=40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
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<u>Definition of</u> $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **<u>Remark 38:</u>** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40}<(\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt}\leq\left((\widehat{M}_{40})^{(8)}\right)_1-(a'_{41})^{(8)}G_{41}$ and by integrating $G_{41}\leq\left((\widehat{M}_{40})^{(8)}\right)_2=G_{41}^0+2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a'_{41})^{(8)}$ In the same way , one can obtain $G_{42}\leq\left((\widehat{M}_{40})^{(8)}\right)_3=G_{42}^0+2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a'_{42})^{(8)}$	276

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}\ (t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\big((G_{43})(t),t(t),t\big) = (b_{42}')^{(8)}$	279
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$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})} : \big(\widetilde{(G_{47})},\widetilde{(T_{47})}\big) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$
$\int_0^t \{(a_{44}')^{(9)} |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)} |(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a_{44}'')^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}| e^{-(\widehat{M}_{44})^{(9)} t} \leq \frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)} \right) d \left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)} \right) \right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)} \right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $((\widehat{M}_{44})^{(9)})_1, ((\widehat{M}_{44})^{(9)})_2$ *and* $((\widehat{M}_{44})^{(9)})_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq ((\widehat{M}_{44})^{(9)})_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$$G_{45} \leq ((\widehat{M}_{44})^{(9)})_2 = G_{45}^0 + 2(a_{45})^{(9)} ((\widehat{M}_{44})^{(9)})_1 / (a_{45}')^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq ((\widehat{M}_{44})^{(9)})_3 = G_{46}^0 + 2(a_{46})^{(9)} ((\widehat{M}_{44})^{(9)})_2 / (a_{46}')^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t),t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t),t) = (b_{46}^{'})^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14},t) + (a_{14}^{''})^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if \ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$ and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$	283

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
<u>Definition of</u> $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
<u>Behavior of the solutions of equation</u>	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}\big((G_{19}), t\big) - (b''_{17})^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\big(u^{(2)}\big)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G^0_{16}}{G^0_{17}}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T^0_{16}}{T^0_{17}}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^{0} e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^{0} e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^{0} e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^{0} e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^{0}}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^{0} e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^{0}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^{0} e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
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$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b'_{30})^{(5)}t}\right]+T_{30}^0 e^{-(b'_{30})^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
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and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ ,\boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
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$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
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$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)},\ \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}] + G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}')^{(7)}$ $(R_2)^{(7)} = (b_{38}')^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}')^{(8)} + (a_{41}')^{(8)} - (a_{40}'')^{(8)}(T_{41}, t) + (a_{41}'')^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}')^{(8)} + (b_{41}')^{(8)} - (b_{40}'')^{(8)}((G_{43}), t) - (b_{41}'')^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}(\nu^{(8)})^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},$ ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},$ ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)},$ ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})} \left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t} \right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq \right.$ $\left. \frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}^{'})^{(8)})} [e^{(S_1)^{(8)}t} - e^{-(a_{42}^{'})^{(8)}t}] + G_{42}^0 e^{-(a_{42}^{'})^{(8)}t} \right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)}T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)}T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a_{44}')^{(9)} + (a_{45}')^{(9)} - (a_{44}'')^{(9)}(T_{45}, t) + (a_{45}'')^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b_{44}')^{(9)} + (b_{45}')^{(9)} - (b_{44}'')^{(9)}((G_{47}), t) - (b_{45}'')^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},$ ***if*** $(\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, ***if*** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, ***if*** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, ***if*** $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, ***if*** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, ***if*** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)} t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)} t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)} - (p_{44})^{(9)} - (S_2)^{(9)})} \left[e^{((S_1)^{(9)} - (p_{44})^{(9)})t} - e^{-(S_2)^{(9)} t} \right] + G_{46}^0 e^{-(S_2)^{(9)} t} \leq G_{46}(t) \leq$$
$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)} - (a_{46}')^{(9)})} \left[e^{(S_1)^{(9)} t} - e^{-(a_{46}')^{(9)} t} \right] + G_{46}^0 e^{-(a_{46}')^{(9)} t} \Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)} t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)} + (r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)} t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)} + (r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)} - (b_{46}')^{(9)})} \left[e^{(R_1)^{(9)} t} - e^{-(b_{46}')^{(9)} t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)} t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)} + (r_{44})^{(9)} + (R_2)^{(9)})} \left[e^{((R_1)^{(9)} + (r_{44})^{(9)})t} - e^{-(R_2)^{(9)} t} \right] + T_{46}^0 e^{-(R_2)^{(9)} t}$$

<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)} (m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)} (\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$	
Proof : From global equations we obtain $\frac{dv^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$	386

And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\quad \boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
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In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a_{16}'')^{(2)} = (a_{17}'')^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)} G_{17}(t)$ Analogously if $(b_{16}'')^{(2)} = (b_{17}'')^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)} T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

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Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
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If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{24}'')^{(4)} = (a_{25}'')^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b_{24}'')^{(4)} = (b_{25}'')^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}')^{(5)} - (a_{29}')^{(5)} + (a_{28}'')^{(5)}(T_{29}, t)\right) - (a_{29}'')^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)}$, $\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)}$, $\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \le \frac{d\nu^{(8)}}{dt} \le -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \ge \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \le \nu^{(8)}(t) \le (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \le \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \le \nu^{(8)}(t) \le (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \le \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \le \nu^{(8)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \le (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \le (\bar{\nu}_1)^{(8)} \le \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \le \nu^{(8)}(t) \le \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \le (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$**.**

Proof : From 99,20,44,22,23,44 we obtain 424 A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}'')^{(9)} = (a_{45}'')^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}'')^{(9)} = (b_{45}'')^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i'')^{(1)} and\ (b_i'')^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}')^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ *with* $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)}$ *and* $(b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ *with* $(p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)}$ *and* $(b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ *with* $(p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)}$ *and* $(b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ *with* $(p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b'_{44})^{(9)}(r_{45})^{(9)} - (b'_{45})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (n) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
<u>Definition and uniqueness of</u> T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
<u>Definition and uniqueness of</u> T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
<u>Definition and uniqueness of</u> T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right]+(b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right]+(b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27}) + (b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right] + (b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31}) + (b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right] + (b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
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By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39}) + (b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right] + (b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*) = 0$	510
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Finally we obtain the unique solution G^*_{14} given by $\varphi(G^*) = 0$, T^*_{14} given by $f(T^*_{14}) = 0$ and $G^*_{13} = \frac{(a_{13})^{(1)} G^*_{14}}{[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T^*_{14})]}$, $G^*_{15} = \frac{(a_{15})^{(1)} G^*_{14}}{[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T^*_{14})]}$ $T^*_{13} = \frac{(b_{13})^{(1)} T^*_{14}}{[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G^*)]}$, $T^*_{15} = \frac{(b_{15})^{(1)} T^*_{14}}{[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G^*_{17} given by $\varphi((G_{19})^*) = 0$, T^*_{17} given by $f(T^*_{17}) = 0$ and	512
$G^*_{16} = \frac{(a_{16})^{(2)} G^*_{17}}{[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T^*_{17})]}$, $G^*_{18} = \frac{(a_{18})^{(2)} G^*_{17}}{[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T^*_{17})]}$	513
$T^*_{16} = \frac{(b_{16})^{(2)} T^*_{17}}{[(b'_{16})^{(2)} - (b''_{16})^{(2)}((G_{19})^*)]}$, $T^*_{18} = \frac{(b_{18})^{(2)} T^*_{17}}{[(b'_{18})^{(2)} - (b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G^*_{21} given by $\varphi((G_{23})^*) = 0$, T^*_{21} given by $f(T^*_{21}) = 0$ and $G^*_{20} = \frac{(a_{20})^{(3)} G^*_{21}}{[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T^*_{21})]}$, $G^*_{22} = \frac{(a_{22})^{(3)} G^*_{21}}{[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T^*_{21})]}$ $T^*_{20} = \frac{(b_{20})^{(3)} T^*_{21}}{[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}{}^*)]}$, $T^*_{22} = \frac{(b_{22})^{(3)} T^*_{21}}{[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
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$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}(\,(G_{19})^*\,) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}(\,(G_{23})^*\,) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt}=-\left((b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)\mathbb{T}_{20}+(b_{20})^{(3)}\mathbb{T}_{21}+\sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt}=-\left((b_{21}^{'})^{(3)}-(r_{21})^{(3)}\right)\mathbb{T}_{21}+(b_{21})^{(3)}\mathbb{T}_{20}+\sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt}=-\left((b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\mathbb{T}_{22}+(b_{22})^{(3)}\mathbb{T}_{21}+\sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i,\mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad ,T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*})=(q_{25})^{(4)} \quad , \frac{\partial(b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}\ )=s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt}=-\left((a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)\mathbb{G}_{24}+(a_{24})^{(4)}\mathbb{G}_{25}-(q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt}=-\left((a_{25}^{'})^{(4)}+(p_{25})^{(4)}\right)\mathbb{G}_{25}+(a_{25})^{(4)}\mathbb{G}_{24}-(q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt}=-\left((a_{26}^{'})^{(4)}+(p_{26})^{(4)}\right)\mathbb{G}_{26}+(a_{26})^{(4)}\mathbb{G}_{25}-(q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt}=-\left((b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)\mathbb{T}_{24}+(b_{24})^{(4)}\mathbb{T}_{25}+\sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt}=-\left((b_{25}^{'})^{(4)}-(r_{25})^{(4)}\right)\mathbb{T}_{25}+(b_{25})^{(4)}\mathbb{T}_{24}+\sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt}=-\left((b_{26}^{'})^{(4)}-(r_{26})^{(4)}\right)\mathbb{T}_{26}+(b_{26})^{(4)}\mathbb{T}_{25}+\sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
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Definition of $\mathbb{G}_i,\mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad ,T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*})=(q_{29})^{(5)} \quad , \frac{\partial(b_i^{''})^{(5)}}{\partial G_j}(\ (G_{31})^{*}\ )=s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G^*_{28}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G^*_{29}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G^*_{30}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T^*_{28}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T^*_{29}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T^*_{30}\mathbb{G}_j\right)$	562
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Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{33})^{(6)}}{\partial T_{33}}(T^*_{33}) = (q_{33})^{(6)} \quad , \frac{\partial (b''_i)^{(6)}}{\partial G_j}((G_{35})^*) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G^*_{32}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G^*_{33}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G^*_{34}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T^*_{32}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T^*_{33}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T^*_{34}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ *and* $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{37})^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b''_i)^{(7)}}{\partial G_j} \left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a'_{36})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a'_{37})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}} (T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b''_i)^{(8)}}{\partial G_j} \left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt}=-\left((a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)\mathbb{G}_{42}+(a_{42})^{(8)}\mathbb{G}_{41}-(q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt}=-\left((b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)\mathbb{T}_{40}+(b_{40})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt}=-\left((b_{41}^{'})^{(8)}-(r_{41})^{(8)}\right)\mathbb{T}_{41}+(b_{41})^{(8)}\mathbb{T}_{40}+\sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt}=-\left((b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\mathbb{T}_{42}+(b_{42})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial(b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt}=-\left((a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\mathbb{G}_{44}+(a_{44})^{(9)}\mathbb{G}_{45}-(q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt}=-\left((a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)\mathbb{G}_{45}+(a_{45})^{(9)}\mathbb{G}_{44}-(q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt}=-\left((a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)\mathbb{G}_{46}+(a_{46})^{(9)}\mathbb{G}_{45}-(q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt}=-\left((b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)\mathbb{T}_{44}+(b_{44})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt}=-\left((b_{45}^{'})^{(9)}-(r_{45})^{(9)}\right)\mathbb{T}_{45}+(b_{45})^{(9)}\mathbb{T}_{44}+\sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt}=-\left((b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\mathbb{T}_{46}+(b_{46})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)}+(b_{15}^{'})^{(1)}-(r_{15})^{(1)}\right)\{\left((\lambda)^{(1)}+(a_{15}^{'})^{(1)}+(p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$ +	
$((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)})$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)})$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$	

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$$+\left(\left((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$$

$$+$$

$$\left((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$$+$$

$$\left((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}')^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}')^{(7)}+(b_{37}')^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b_{42}')^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}')^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}')^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}')^{(8)}+(b_{41}')^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b_{46}')^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}')^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(\left((\lambda)^{(9)}+(a_{45}')^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION FIFTEEN

Fields And Fluids On Curved Non-Relativistic Spacetimes

INTRODUCTION—VARIABLES USED

Hydrodynamics on the lowest Landau level Michael Geracie, Dam Thanh Son

(1) Kubo formulas are presented for (e) all transport coefficients and constraints from (e) Weyl invariance derived.
(2) Authors also present a number of Streda-type formulas for (e) the equilibrium response to (e&eb) external electric, magnetic and gravitational fields. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); High Energy Physics - Theory (hep-th) Cite as: arXiv: 1408.6843 [cond-mat.mes-hall] (or arXiv: 1408.6843v1 [cond-mat.mes-hall] for this version)

Fields and fluids on curved non-relativistic spacetimes Michael Geracie, Kartik Prabhu, Matthew M. Roberts

(3) Authors consider non-relativistic curved geometries and argue that the background structure should be generalized from (e) that considered in previous works
(4) In this approach the derivative operator is defined by (e) a Galilean spin connection valued in the

Lie algebra of the Galilean group.

(5) This includes (e) the usual spin connection plus an additional "boost connection" which parameterizes (e&eb) the freedom in the derivative operator not fixed by (e) torsion or metric compatibility.

(6) As an example authors write down the most general theory of dissipative fluids consistent with (e&eb) the second law in curved non-relativistic geometries and find (eb) significant differences in the allowed transport coefficients from (e) those found previously

(7) . Kubo formulas for all response coefficients are presented. Approach also immediately generalizes (eb) to systems with (e&eb) independent mass and charge currents as would arise (eb) in multicomponent fluids.

(8) Along the way authors also discuss how to write general locally Galilean invariant non-relativistic actions for (e) multiple particle species at any order in derivatives. A detailed review of the geometry and its relation to (e&eb) non-relativistic limits may be found in a companion paper [arXiv: 1503.02682]. Subjects: High Energy Physics - Theory (hep-th); Mesoscale and Nanoscale Physics (cond-mat.mes-hall) journal reference: JHEP 08 (2015) 042 DOI: 10.1007/JHEP08 (2015)042 Report number: EFI-15-13 Cite as: arXiv:1503.02680 [hep-th] (or arXiv:1503.02680v6 [hep-th] for this version)

NOTATION

Module One

An entropy current analysis further constrains the energy response, determining four transverse response functions in terms of (e&eb) only two: an energy magnetization and (e&eb) a thermal Hall conductivity

G_{13} : Category one of **energy magnetization;** thermal Hall conductivity

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of thermal Hall conductivity **;energy magnetization**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Kubo formulas are presented for (e) all transport coefficients and constraints from (e) Weyl invariance derived

G_{16} : Category one of **Kubo formulas;** all transport coefficients and constraints from (e) Weyl invariance

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of all transport coefficients and constraints from (e) Weyl invariance ;**Kubo formulas**

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

Authors also present a number of Streda-type formulas for (e) the equilibrium response to (e&eb) external electric, magnetic and gravitational fields. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); High Energy Physics - Theory (hep-th) Cite as: arXiv: 1408.6843 [cond-mat.mes-hall] (or arXiv: 1408.6843v1 [cond-mat.mes-hall] for this version)	
G_{20} : Category one of **Streda-type formulas;** equilibrium response to (e&eb) external electric, magnetic and gravitational fields. G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of equilibrium response to (e&eb) external electric, magnetic and gravitational fields; **Streda-type formulas** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Authors also present a number of Streda-type formulas for the equilibrium response to (e&eb) external electric, magnetic and gravitational fields	
G_{24} : Category one of **Streda-type formulas for the equilibrium response;** external electric, magnetic and gravitational fields G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of external electric, magnetic and gravitational fields **;Streda-type formulas for the equilibrium response** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Authors consider non-relativistic curved geometries and argue that the background structure should be generalized from that considered in previous works	
G_{28} : Category one of background structure under consideration of non-relativistic curved geometries; **generalized from that considered in previous works** G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of **generalized from that considered in previous works** ;background structure under consideration of non-relativistic curved geometries	

T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six In this approach the derivative operator is defined by (e) a Galilean spin connection valued in the Lie algebra of the Galilean group	
G_{32} : Category one of **derivative operator;** Galilean spin connection valued in the Lie algebra of the Galilean group G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of Galilean spin connection valued in the Lie algebra of the Galilean group **;derivative operator** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven Galilean spin connection valued in the Lie algebra of the Galilean group includes (e) the usual spin connection plus an additional "boost connection" which parameterizes (e&eb) the freedom in the derivative operator not fixed by (e) torsion or metric compatibility	
G_{36} : Category one of **Galilean spin connection valued in the Lie algebra of the Galilean group;** usual spin connection plus an additional "boost connection" which parameterizes (e&eb) the freedom in the derivative operator not fixed by (e) torsion or metric compatibility G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of usual spin connection plus an additional "boost connection" which parameterizes (e&eb) the freedom in the derivative operator not fixed by (e) torsion or metric compatibility **;Galilean spin connection valued in the Lie algebra of the Galilean group** T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight Galilean spin connection valued in the Lie algebra of the Galilean group includes the usual spin connection plus an additional "boost connection" which parameterizes (e&eb) the **freedom in the derivative operator not fixed by (e) torsion or metric compatibility**	

G_{40} : Category one of Galilean spin connection valued in the Lie algebra of the Galilean group includes the usual spin connection plus an additional "boost connection"; **freedom in the derivative operator not fixed by torsion or metric compatibility** G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of **freedom in the derivative operator not fixed by (e) torsion or metric compatibility** ;Galilean spin connection valued in the Lie algebra of the Galilean group includes the usual spin connection plus an additional "boost connection" T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine As an example authors write down the most general theory of dissipative fluids consistent with (e&eb) the second law in curved non-relativistic geometries and find (eb) significant differences in the allowed transport coefficients from those found previously	
G_{44} : Category one of **most general theory of dissipative fluids;** second law in curved non-relativistic geometries and find (eb) significant differences in the allowed transport coefficients from (e) those found previously G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of second law in curved non-relativistic geometries and find (eb) significant differences in the allowed transport coefficients from (e) those found previously; **most general theory of dissipative fluids** T_{45} : Category two of SAS T_{46} : Category three of SAS	

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients	

$(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}, (b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$ $, (a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)} (a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t)\right]T_{21}$	17

$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	

$\frac{dG_{36}}{dt}=(a_{36})^{(7)}G_{37}-\left[(a'_{36})^{(7)}+(a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt}=(a_{37})^{(7)}G_{36}-\left[(a'_{37})^{(7)}+(a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	38
$\frac{dG_{38}}{dt}=(a_{38})^{(7)}G_{37}-\left[(a'_{38})^{(7)}+(a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	39
$\frac{dT_{36}}{dt}=(b_{36})^{(7)}T_{37}-\left[(b'_{36})^{(7)}-(b''_{36})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	40
$\frac{dT_{37}}{dt}=(b_{37})^{(7)}T_{36}-\left[(b'_{37})^{(7)}-(b''_{37})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	41
$\frac{dT_{38}}{dt}=(b_{38})^{(7)}T_{37}-\left[(b'_{38})^{(7)}-(b''_{38})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	42
$+(a''_{36})^{(7)}(T_{37},t)=$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt}=(a_{40})^{(8)}G_{41}-\left[(a'_{40})^{(8)}+(a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	43
$\frac{dG_{41}}{dt}=(a_{41})^{(8)}G_{40}-\left[(a'_{41})^{(8)}+(a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	44
$\frac{dG_{42}}{dt}=(a_{42})^{(8)}G_{41}-\left[(a'_{42})^{(8)}+(a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	45
$\frac{dT_{40}}{dt}=(b_{40})^{(8)}T_{41}-\left[(b'_{40})^{(8)}-(b''_{40})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	46
$\frac{dT_{41}}{dt}=(b_{41})^{(8)}T_{40}-\left[(b'_{41})^{(8)}-(b''_{41})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	47
$\frac{dT_{42}}{dt}=(b_{42})^{(8)}T_{41}-\left[(b'_{42})^{(8)}-(b''_{42})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt}=(a_{44})^{(9)}G_{45}-\left[(a'_{44})^{(9)}+(a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt}=(a_{45})^{(9)}G_{44}-\left[(a'_{45})^{(9)}+(a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt}=(a_{46})^{(9)}G_{45}-\left[(a'_{46})^{(9)}+(a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt}=(b_{44})^{(9)}T_{45}-\left[(b'_{44})^{(9)}-(b''_{44})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt}=(b_{45})^{(9)}T_{44}-\left[(b'_{45})^{(9)}-(b''_{45})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt}=(b_{46})^{(9)}T_{45}-\left[(b'_{46})^{(9)}-(b''_{46})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t)=$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right)=$ **First detrition factor**	
$\frac{dG_{13}}{dt}=(a_{13})^{(1)}G_{14}-\begin{bmatrix}(a'_{13})^{(1)}\boxed{+(a''_{13})^{(1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{13}$	55
$\frac{dG_{14}}{dt}=(a_{14})^{(1)}G_{13}-\begin{bmatrix}(a'_{14})^{(1)}\boxed{+(a''_{14})^{(1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{14}$	56
$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\begin{bmatrix}(a'_{15})^{(1)}\boxed{+(a''_{15})^{(1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{15}$	57

Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16}$	*61*
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{17}$	*62*
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{18}$	*63*
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$$ 64

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$$ 65

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$$ 66

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$$ 67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$$ 68

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a_{22}^{'})^{(3)} \boxed{+(a_{22}^{''})^{(3)}(T_{21},t)} \boxed{+(a_{18}^{''})^{(2,2,2)}(T_{17},t)} \boxed{+(a_{15}^{''})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22}$$ 69

$\boxed{+(a_{20}^{''})^{(3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}^{''})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{13}^{''})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{36}^{''})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}^{''})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}^{''})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{40}^{''})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{44}^{''})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b_{20}^{'})^{(3)} \boxed{-(b_{20}^{''})^{(3)}(G_{23},t)} \boxed{-(b_{16}^{''})^{(2,2,2)}(G_{19},t)} \boxed{-(b_{13}^{''})^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}^{''})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}^{''})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{20}$$ 70

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b_{21}^{'})^{(3)} \boxed{-(b_{21}^{''})^{(3)}(G_{23},t)} \boxed{-(b_{17}^{''})^{(2,2,2)}(G_{19},t)} \boxed{-(b_{14}^{''})^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}^{''})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}^{''})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21}$$ 71

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b_{22}^{'})^{(3)} \boxed{-(b_{22}^{''})^{(3)}(G_{23},t)} \boxed{-(b_{18}^{''})^{(2,2,2)}(G_{19},t)} \boxed{-(b_{15}^{''})^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{38}^{''})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}^{''})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22}$$ 72

$\boxed{-(b_{20}^{''})^{(3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{16}^{''})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{13}^{''})^{(1,1,1,)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3*

$-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3*

$-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3*

$-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t) + (a''_{28})^{(5,5,)}(T_{29},t) + (a''_{32})^{(6,6,)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1)}(T_{14},t) + (a''_{16})^{(2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{36})^{(7,7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8,8)}(T_{41},t) + (a''_{44})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{24}$$ 73

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25},t) + (a''_{29})^{(5,5,)}(T_{29},t) + (a''_{33})^{(6,6)}(T_{33},t) \\ +(a''_{14})^{(1,1,1,1)}(T_{14},t) + (a''_{17})^{(2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{37})^{(7,7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{25}$$ 74

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25},t) + (a''_{30})^{(5,5,)}(T_{29},t) + (a''_{34})^{(6,6,)}(T_{33},t) \\ +(a''_{15})^{(1,1,1,1)}(T_{14},t) + (a''_{18})^{(2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{38})^{(7,7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{26}$$ 75

$(a''_{24})^{(4)}(T_{25},t)$, $(a''_{25})^{(4)}(T_{25},t)$, $(a''_{26})^{(4)}(T_{25},t)$ *are first augmentation coefficients category* 1, 2 3

$+(a''_{28})^{(5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3

$+(a''_{32})^{(6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3

$+(a''_{13})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1)}(T_{14},t)$
are fourth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{16})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2)}(T_{17},t)$
are fifth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{20})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3)}(T_{21},t)$
are sixth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$
are seventh augmentation coefficients for category 1, 2 *and* 3

$+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)$
are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\begin{bmatrix}(b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{24}$	76
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\begin{bmatrix}(b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{25}$	77
$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\begin{bmatrix}(b'_{26})^{(4)}\boxed{-(b''_{26})^{(4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{26}$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\begin{bmatrix}(a'_{28})^{(5)}\boxed{+(a''_{28})^{(5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{28}$	79
$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\begin{bmatrix}(a'_{29})^{(5)}\boxed{+(a''_{29})^{(5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{29}$	80

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30} \qquad 81$$

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28} \qquad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29} \qquad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30} \qquad 84$$

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32} \quad (85)$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33} \quad (86)$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34} \quad (87)$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$

seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$

Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32} \qquad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)}\boxed{-(b''_{33})^{(6)}(G_{35},t)}\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33} \qquad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)}\boxed{-(b''_{34})^{(6)}(G_{35},t)}\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34} \qquad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)}\boxed{+(a''_{36})^{(7)}(T_{37},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13} \qquad 91$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$ 92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$ 93

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$ 94

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[\begin{array}{l} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{array} \right] G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[\begin{array}{l} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array} \right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[\begin{array}{l} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array} \right] T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)}\boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{13}$$ 96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)}\boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45}-\left[\begin{array}{ccc}(b'_{46})^{(9)}\boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{array}\right]T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(1)}, (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \le (p_i)^{(1)} \le (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \le (r_i)^{(1)} \le (b'_i)^{(1)} \le (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t) = (r_i)^{(1)}$ **<u>Definition of</u>** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\|(a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14}-T_{14}'\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G-G'\|\|e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)}$, $(r_i)^{(1)}, i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i')^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i')^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0, \quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}$, $(r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}((G_{19}),t)=(r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i=16,17,18$	106
They satisfy Lipschitz condition:	

$\left\|(a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\right\| \leq (\hat{k}_{16})^{(2)}\left\|T_{17}-T_{17}'\right\|e^{-(\hat{M}_{16})^{(2)}t}$	107
$\left\|(b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\right\| < (\hat{k}_{16})^{(2)}\left\|(G_{19})-(G_{19})'\right\|e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
<u>Definition of</u> $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)}+(a_i')^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\,(\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i')^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(3)},\ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21},t)\leq(p_i)^{(3)}\leq(\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t)\leq\ (r_i)^{(3)}\leq(b_i')^{(3)}\leq(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}\,(T_{21},t)=(p_i)^{(3)}$ $\mathrm{lim}_{\mathrm{G}\to\infty}(b_i'')^{(3)}\,(G_{23},t)=\ (r_i)^{(3)}$ **<u>Definition of</u>** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}}$ are positive constants and $\boxed{i=20,21,22}$	113

They satisfy Lipschitz condition: $\|(a_i^{''})^{(3)}(T_{21}^{'},t)-(a_i^{''})^{(3)}(T_{21},t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21}-T_{21}^{'}\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i^{''})^{(3)}(G_{23}{}^{'},t)-(b_i^{''})^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23}-G_{23}{}^{'}\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'},t)$ and$(a_i^{''})^{(3)}(T_{21},t)$. $(T_{21}^{'},t)$ And (T_{21},t) are points belonging to the interval $[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i^{''})^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i^{'})^{(3)},(b_i)^{(3)},(b_i^{'})^{(3)},(p_i)^{(3)},(r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)}+(a_i^{'})^{(3)}+(\hat{A}_{20})^{(3)}+(\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)}+(b_i^{'})^{(3)}+(\hat{B}_{20})^{(3)}+(\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}]<1$	116
Where we suppose	
$(a_i)^{(4)},(a_i^{'})^{(4)},(a_i^{''})^{(4)},(b_i)^{(4)},(b_i^{'})^{(4)},(b_i^{''})^{(4)}>0, \quad i,j=24,25,26$ The functions $(a_i^{''})^{(4)},(b_i^{''})^{(4)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i^{''})^{(4)}((G_{27}),t)=(r_i)^{(4)}$ <u>**Definition of**</u> $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},(r_i)^{(4)}$ are positive constants and $i=24,25,26$	118
They satisfy Lipschitz condition:	119

$\lvert(a_i^{''})^{(4)}(T_{25}^{'},t)-(a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t)-(b_i^{''})^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and$(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}$, $\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i^{'})^{(4)},(b_i)^{(4)},(b_i^{'})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}, i=24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)}+(a_i^{'})^{(4)}+(\hat{A}_{24})^{(4)}+(\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)}+(b_i^{'})^{(4)}+(\hat{B}_{24})^{(4)}+(\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i^{'})^{(5)},(a_i^{''})^{(5)},(b_i)^{(5)},(b_i^{'})^{(5)},(b_i^{''})^{(5)}>0,\quad i,j=28,29,30$ The functions $(a_i^{''})^{(5)},(b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)},\ (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t)\leq(p_i)^{(5)}\leq(\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}),t)\leq\ (r_i)^{(5)}\leq(b_i^{'})^{(5)}\leq(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t)=\ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}$ are positive constants and $i=28,29,30$	123

They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29}-T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31})-(G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and $(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
Definition of $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and\ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(p_i)^{(5)},\ (r_i)^{(5)},i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)}+(a_i')^{(5)}+\ (\hat{A}_{28})^{(5)}+\ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)}+(b_i')^{(5)}+\ (\hat{B}_{28})^{(5)}+\ (\hat{Q}_{28})^{(5)}\ \ (\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i')^{(6)},(a_i'')^{(6)},(b_i)^{(6)},(b_i')^{(6)},(b_i'')^{(6)}>0,\quad i,j=32,33,34$ The functions $(a_i'')^{(6)},(b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)},\ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t)\leq(p_i)^{(6)}\leq(\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t)\leq\ (r_i)^{(6)}\leq(b_i')^{(6)}\leq(\hat{B}_{32})^{(6)}$	127
$lim_{T_2\to\infty}(a_i'')^{(6)}\,(T_{33},t)=(p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}\left((G_{35}),t\right)=\ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$:	128

Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}',t) - (a_i'')^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}' \rvert e^{-(\hat{M}_{32})^{(6)}t}$; $\lvert(b_i'')^{(6)}((G_{35})',t) - (b_i'')^{(6)}((G_{35}),t)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert (G_{35}) - (G_{35})' \rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}',t)$ and $(a_i'')^{(6)}(T_{33},t)$. (T_{33}',t) and (T_{33},t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}, \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$; $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(GGGG) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (HHHH)The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$; $(b_i'')^{(7)}(G_{39},t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(IIII) $\lim_{T_2 \to \infty} (a_i'')^{(7)}(T_{37},t) = (p_i)^{(7)}$ *(JJJJ)* $\lim_{G \to \infty} (b_i'')^{(7)}((G_{39}),t) = (r_i)^{(7)}$	132

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}',t) - (a_i'')^{(7)}(T_{37},t)\rvert \le (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})',t) - (b_i'')^{(7)}((G_{39}),t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}',t)$ and $(a_i'')^{(7)}(T_{37},t)$. (T_{37}',t) and (T_{37},t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i'')^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (KKKK) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (LLLL) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and\ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[\,(a_i)^{(7)} + (a_i')^{(7)} + \ (\hat{A}_{36})^{(7)} + \ (\hat{P}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[\ (b_i)^{(7)} + (b_i')^{(7)} + \ (\hat{B}_{36})^{(7)} + \ (\hat{Q}_{36})^{(7)}\ \ (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, \ (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41},t) \le (p_i)^{(8)} \le (\hat{A}_{40})^{(8)}$	138

$(b_i^{''})^{(8)}((G_{43}),t) \leq \ (r_i)^{(8)} \leq (b_i^{'})^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i^{''})^{(8)}(T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i^{''})^{(8)}\big((G_{43}),t\big) = \ (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'},t) - (a_i^{''})^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}^{'}\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i^{''})^{(8)}((G_{43})^{'},t) - (b_i^{''})^{(8)}\big((G_{43}),t\big)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})^{'}\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}^{'},t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. $(T_{41}^{'},t)$ and (T_{41},t) are points belonging to the interval $\big[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\big]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}} \ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i^{'})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[\ (a_i)^{(8)} + (a_i^{'})^{(8)} + \ (\hat{A}_{40})^{(8)} + \ (\hat{P}_{40})^{(8)} \ (\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[\ (b_i)^{(8)} + (b_i^{'})^{(8)} + \ (\hat{B}_{40})^{(8)} + \ (\hat{Q}_{40})^{(8)} \ (\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i^{'})^{(9)}, (a_i^{''})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (b_i^{''})^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i'')^{(9)}, (b_i'')^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$$(a_i'')^{(9)}(T_{45},t) \le (p_i)^{(9)} \le (\hat{A}_{44})^{(9)}$$

$$(b_i'')^{(9)}(G_{47},t) \le (r_i)^{(9)} \le (b_i')^{(9)} \le (\hat{B}_{44})^{(9)}$$

$$\lim_{T_2\to\infty} (a_i'')^{(9)}(T_{45},t) = (p_i)^{(9)}$$

$$\lim_{G\to\infty} (b_i'')^{(9)}(G_{47},t) = (r_i)^{(9)}$$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$$|(a_i'')^{(9)}(T_{45}',t) - (a_i'')^{(9)}(T_{45},t)| \le (\hat{k}_{44})^{(9)}|T_{45} - T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i'')^{(9)}((G_{47})',t) - (b_i'')^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $\left[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\right]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)} + (a_i')^{(9)} + \ (\hat{A}_{44})^{(9)} + \ (\hat{P}_{44})^{(9)}\,(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\,(b_i)^{(9)} + (b_i')^{(9)} + \ (\hat{B}_{44})^{(9)} + \ (\hat{Q}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions <u>Definition of</u> $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13} \right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **<u>Definition of</u>** $G_i(0)\,,T_i(0)$ $G_i(t) \leq \ (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq \ (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq \ (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq \ (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **<u>Definition of</u>** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24} \right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **<u>Definition of</u>** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28} \right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **<u>Definition of</u>** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32} \right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **<u>Definition of</u>** $G_i(0)\,,T_i(0)$:	153

$G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0\,,\; T_i(0) = T_i^0\,,\; G_i^0 \le (\,\hat{P}_{16}\,)^{(2)}\,, T_i^0 \le (\,\hat{Q}_{16}\,)^{(2)},$	
$0 \le G_i(t) - G_i^0 \le (\,\hat{P}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)} t}$	
$0 \le T_i(t) - T_i^0 \le (\,\hat{Q}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{16}(s_{(16)}) \right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)} (T_{17}(s_{(16)}), s_{(17)}) \right) G_{17}(s_{(16)}) \right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{18}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{16}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{17}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{18}(s_{(16)}) \right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\,,\; T_i(0) = T_i^0\,,\; G_i^0 \le (\,\hat{P}_{20}\,)^{(3)}\,, T_i^0 \le (\,\hat{Q}_{20}\,)^{(3)},$	
$0 \le G_i(t) - G_i^0 \le (\,\hat{P}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)} t}$	
$0 \le T_i(t) - T_i^0 \le (\,\hat{Q}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{20}(s_{(20)}) \right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{21}(s_{(20)}) \right] ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\overline{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{32})^{(6)}$, $T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\overline{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,, T_i(0) = T_i^0 \,, G_i^0 \leq (\hat{P}_{36})^{(7)} \,, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \Big[(a_{36})^{(7)} G_{37}(s_{(36)}) - \Big((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)}\big(T_{37}(s_{(36)}), s_{(36)}\big)\Big) G_{36}(s_{(36)})\Big] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \Big[(a_{37})^{(7)} G_{36}(s_{(36)}) - \Big((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}\big(T_{37}(s_{(36)}), s_{(36)}\big)\Big) G_{37}(s_{(36)})\Big] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \Big[(a_{38})^{(7)} G_{37}(s_{(36)}) - \Big((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}\big(T_{37}(s_{(36)}), s_{(36)}\big)\Big) G_{38}(s_{(36)})\Big] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \Big[(b_{36})^{(7)} T_{37}(s_{(36)}) - \Big((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\big(G_{39}(s_{(36)}), s_{(36)}\big)\Big) T_{36}(s_{(36)})\Big] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \Big[(b_{37})^{(7)} T_{36}(s_{(36)}) - \Big((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\big(G_{39}(s_{(36)}), s_{(36)}\big)\Big) T_{37}(s_{(36)})\Big] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \Big[(b_{38})^{(7)} T_{37}(s_{(36)}) - \Big((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\big(G_{39}(s_{(36)}), s_{(36)}\big)\Big) T_{38}(s_{(36)})\Big] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,, T_i(0) = T_i^0 \,, G_i^0 \leq (\hat{P}_{40})^{(8)} \,, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \Big[(a_{40})^{(8)} G_{41}(s_{(40)}) - \Big((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)}\big(T_{41}(s_{(40)}), s_{(40)}\big)\Big) G_{40}(s_{(40)})\Big] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \Big[(a_{41})^{(8)} G_{40}(s_{(40)}) - \Big((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}\big(T_{41}(s_{(40)}), s_{(40)}\big)\Big) G_{41}(s_{(40)})\Big] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{46}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{46}(s_{(44)}) \right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	167
From which it follows that	168

$(G_{13}(t) - G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)}\left(G_{17}^0 + (\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)}t\right)G_{17}^0 + \frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)}\left(G_{21}^0 + (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)}t\right)G_{21}^0 + \frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t} - 1\right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{P}_{20})^{(3)} + G_{21}^0\right)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)} + (\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)}\left(G_{25}^0 + (\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)}t\right)G_{25}^0 + \frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t} - 1\right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)} + G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)} + (\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

that

$$G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}}\right)\right] ds_{(28)} =$$

$$\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1\right)$$

From which it follows that 175

$$(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0\right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0}\right)} + (\hat{P}_{28})^{(5)}\right]$$

(G_i^0) is as defined in the statement of theorem 5

The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 176

$$G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}}\right)\right] ds_{(32)} =$$

$$\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1\right)$$

From which it follows that 177

$$(G_{32}(t) - G_{32}^0) e^{-(\hat{M}_{32})^{(6)} t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left[\left((\hat{P}_{32})^{(6)} + G_{33}^0\right) e^{\left(-\frac{(\hat{P}_{32})^{(6)} + G_{33}^0}{G_{33}^0}\right)} + (\hat{P}_{32})^{(6)}\right]$$

(G_i^0) is as defined in the statement of theorem 6

Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$

(o) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 178

$$G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} \left(G_{37}^0 + (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} s_{(36)}}\right)\right] ds_{(36)} =$$

$$\left(1 + (a_{36})^{(7)} t\right) G_{37}^0 + \frac{(a_{36})^{(7)} (\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left(e^{(\hat{M}_{36})^{(7)} t} - 1\right)$$

From which it follows that

$$(G_{36}(t) - G_{36}^0) e^{-(\hat{M}_{36})^{(7)} t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right) e^{\left(-\frac{(\hat{P}_{36})^{(7)} + G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$$

(G_i^0) is as defined in the statement of theorem 7

The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that

$$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}}\right)\right] ds_{(40)} =$$ 180

$\left(1+(a_{40})^{(8)}t\right)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41}, G_{42}, T_{40}, T_{41}, T_{42}	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t)\leq G_{44}^0+\int_0^t\left[(a_{44})^{(9)}\left(G_{45}^0+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right]ds_{(44)}=$ $\left(1+(a_{44})^{(9)}t\right)G_{45}^0+\frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$	
From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t}\leq\frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45}, G_{46}, T_{44}, T_{45}, T_{46}	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)}+\left((\hat{P}_{13})^{(1)}+G_j^0\right)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{Q}_{13})^{(1)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{13})^{(1)}\right]\leq(\hat{Q}_{13})^{(1)}$	184
In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left(\left(G^{(1)},T^{(1)}\right),\left(G^{(2)},T^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{13})^{(1)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{13})^{(1)}t}\}$	185

Indeed if we denote

Definition of $\tilde{G}, \tilde{T}$: $(\tilde{G}, \tilde{T}) = \mathcal{A}^{(1)}(G, T)$

It results

$$\left|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{13})^{(1)} \left|G_{14}^{(1)} - G_{14}^{(2)}\right| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} \, ds_{(13)} +$$

$$\int_0^t \{(a_{13}^{'})^{(1)} \left|G_{13}^{(1)} - G_{13}^{(2)}\right| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} +$$

$$(a_{13}^{''})^{(1)} \left(T_{14}^{(1)}, s_{(13)}\right) \left|G_{13}^{(1)} - G_{13}^{(2)}\right| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} +$$

$$G_{13}^{(2)} |(a_{13}^{''})^{(1)} \left(T_{14}^{(1)}, s_{(13)}\right) - (a_{13}^{''})^{(1)} \left(T_{14}^{(2)}, s_{(13)}\right)| \; e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} \} ds_{(13)}$$

Where $s_{(13)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses it follows

$$\left|G^{(1)} - G^{(2)}\right| e^{-(\widehat{M}_{13})^{(1)} t} \leq$$
$$\frac{1}{(\widehat{M}_{13})^{(1)}} \left((a_{13})^{(1)} + (a_{13}^{'})^{(1)} + (\widehat{A}_{13})^{(1)} + (\widehat{P}_{13})^{(1)} (\widehat{k}_{13})^{(1)} \right) d \left(\left(G^{(1)}, T^{(1)}; \; G^{(2)}, T^{(2)} \right) \right)$$ 186

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

<u>Remark 1:</u> The fact that we supposed $(a_{13}^{''})^{(1)}$ and $(b_{13}^{''})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{13})^{(1)} e^{(\widehat{M}_{13})^{(1)} t}$ *and* $(\widehat{Q}_{13})^{(1)} e^{(\widehat{M}_{13})^{(1)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(1)}$ and $(b_i^{''})^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(\textit{and not on } t)$ and hypothesis can replaced by a usual Lipschitz condition.

<u>Remark 2:</u> There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 19 to 24 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(1)} - (a_i^{''})^{(1)} (T_{14}(s_{(13)}), s_{(13)})\} ds_{(13)} \right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(1)} t)} > 0 \quad \text{for } \mathrm{t} > 0$$

<u>Definition of</u> $\left((\widehat{M}_{13})^{(1)}\right)_1, \left((\widehat{M}_{13})^{(1)}\right)_2$ *and* $\left((\widehat{M}_{13})^{(1)}\right)_3$: 187

<u>Remark 3</u>: if G_{13} is bounded, the same property have also G_{14} *and* G_{15} . indeed if

$G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \leq \left((\widehat{M}_{13})^{(1)}\right)_1 - (a_{14}^{'})^{(1)} G_{14}$ and by integrating

$$G_{14} \leq \left((\widehat{M}_{13})^{(1)}\right)_2 = G_{14}^0 + 2(a_{14})^{(1)} \left((\widehat{M}_{13})^{(1)}\right)_1 / (a_{14}^{'})^{(1)}$$

In the same way , one can obtain $G_{15} \leq \left((\widehat{M}_{13})^{(1)} \right)_3 = G_{15}^0 + 2(a_{15})^{(1)} \left((\widehat{M}_{13})^{(1)} \right)_2 / (a_{15}^{'})^{(1)}$ If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.	
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Remark 5: If T_{13} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(1)}(G(t),t)) = (b_{14}^{'})^{(1)}$ then $T_{14} \to \infty$. **Definition of** $(m)^{(1)}$ and ε_1 : Indeed let t_1 be so that for $t > t_1$ $(b_{14})^{(1)} - (b_i^{''})^{(1)}(G(t),t) < \varepsilon_1, T_{13}(t) > (m)^{(1)}$	189
Then $\frac{dT_{14}}{dt} \geq (a_{14})^{(1)}(m)^{(1)} - \varepsilon_1 T_{14}$ which leads to $T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{\varepsilon_1} \right)(1 - e^{-\varepsilon_1 t}) + T_{14}^0 e^{-\varepsilon_1 t}$ If we take t such that $e^{-\varepsilon_1 t} = \frac{1}{2}$ it results $T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{2} \right), \quad t = log\frac{2}{\varepsilon_1}$ By taking now ε_1 sufficiently small one sees that T_{14} is unbounded. The same property holds for T_{15} if $\lim_{t\to\infty}(b_{15}^{''})^{(1)}(G(t),t) = (b_{15}^{'})^{(1)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	
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$\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} \left[(\hat{P}_{16})^{(2)} + \left((\hat{P}_{16})^{(2)} + G_j^0 \right) e^{-\left(\frac{(\hat{P}_{16})^{(2)} + G_j^0}{G_j^0} \right)} \right] \leq (\hat{P}_{16})^{(2)}$	191
$\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{Q}_{16})^{(2)} + T_j^0 \right) e^{-\left(\frac{(\hat{Q}_{16})^{(2)} + T_j^0}{T_j^0} \right)} + (\hat{Q}_{16})^{(2)} \right] \leq (\hat{Q}_{16})^{(2)}$	192
In order that the operator $\mathcal{A}^{(2)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	193
The operator $\mathcal{A}^{(2)}$ is a contraction with respect to the metric $d\left(\left((G_{19})^{(1)}, (T_{19})^{(1)} \right), \left((G_{19})^{(2)}, (T_{19})^{(2)} \right) \right) =$ $\sup_i \{ \max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t) \rvert e^{-(\hat{M}_{16})^{(2)} t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t) \rvert e^{-(\hat{M}_{16})^{(2)} t} \}$	194

Indeed if we denote **Definition of** $\widetilde{G_{19}},\widetilde{T_{19}}$: $\left(\widetilde{G_{19}},\widetilde{T_{19}}\right)=\mathcal{A}^{(2)}(G_{19},T_{19})$	195
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In the same way , one can obtain $G_{18} \leq \left((\widehat{M}_{16})^{(2)}\right)_3 = G_{18}^0 + 2(a_{18})^{(2)}\left((\widehat{M}_{16})^{(2)}\right)_2/(a_{18}')^{(2)}$ If G_{17} or G_{18} is bounded, the same property follows for G_{16} , G_{18} and G_{16} , G_{17} respectively.	
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Then $\frac{dT_{17}}{dt} \geq (a_{17})^{(2)}(m)^{(2)} - \varepsilon_2 T_{17}$ which leads to $T_{17} \geq \left(\frac{(a_{17})^{(2)}(m)^{(2)}}{\varepsilon_2}\right)(1 - e^{-\varepsilon_2 t}) + T_{17}^0 e^{-\varepsilon_2 t}$ If we take t such that $e^{-\varepsilon_2 t} = \frac{1}{2}$ it results	204
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$\frac{(a_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}}\left[(\widehat{P}_{20})^{(3)} + ((\widehat{P}_{20})^{(3)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{20})^{(3)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{20})^{(3)}$	208
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In order that the operator $\mathcal{A}^{(3)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	210
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Indeed if we denote **Definition of** $\widetilde{G_{23}}, \widetilde{T_{23}}$:$\left(\widetilde{(G_{23})}, \widetilde{(T_{23})} \right) = \mathcal{A}^{(3)}\left((G_{23}),(T_{23})\right)$	212
It results $\left\|\tilde{G}_{20}^{(1)} - \tilde{G}_i^{(2)}\right\| \leq \int_0^t (a_{20})^{(3)} \left\|G_{21}^{(1)} - G_{21}^{(2)}\right\| e^{-(\widehat{M}_{20})^{(3)} s_{(20)}} e^{(\widehat{M}_{20})^{(3)} s_{(20)}}\, ds_{(20)} +$ $\int_0^t \{(a_{20}^{'})^{(3)} \left\|G_{20}^{(1)} - G_{20}^{(2)}\right\| e^{-(\widehat{M}_{20})^{(3)} s_{(20)}} e^{-(\widehat{M}_{20})^{(3)} s_{(20)}} +$ $(a_{20}^{''})^{(3)}\left(T_{21}^{(1)}, s_{(20)}\right)\left\|G_{20}^{(1)} - G_{20}^{(2)}\right\| e^{-(\widehat{M}_{20})^{(3)} s_{(20)}} e^{(\widehat{M}_{20})^{(3)} s_{(20)}} +$ $G_{20}^{(2)} \| (a_{20}^{''})^{(3)}\left(T_{21}^{(1)}, s_{(20)}\right) - (a_{20}^{''})^{(3)}\left(T_{21}^{(2)}, s_{(20)}\right) \| \; e^{-(\widehat{M}_{20})^{(3)} s_{(20)}} e^{(\widehat{M}_{20})^{(3)} s_{(20)}}\} ds_{(20)}$ Where $s_{(20)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	213
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Remark 12: There does not exist any t where $G_i\,(t) = 0 \; and \; T_i\,(t) = 0$ it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(3)} - (a_i^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\} ds_{(20)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(3)} t\right)} > 0 \;$ for $\mathrm{t} > 0$	216
Definition of $\left((\widehat{M}_{20})^{(3)}\right)_1, \left((\widehat{M}_{20})^{(3)}\right)_2 \; and \; \left((\widehat{M}_{20})^{(3)}\right)_3$: **Remark 13:** if G_{20} is bounded, the same property have also $G_{21} \; and \; G_{22}$. indeed if $G_{20} < (\widehat{M}_{20})^{(3)}$ it follows $\frac{dG_{21}}{dt} \leq \left((\widehat{M}_{20})^{(3)}\right)_1 - (a_{21}^{'})^{(3)} G_{21}$ and by integrating $G_{21} \leq \left((\widehat{M}_{20})^{(3)}\right)_2 = G_{21}^0 + 2(a_{21})^{(3)}\left((\widehat{M}_{20})^{(3)}\right)_1 / (a_{21}^{'})^{(3)}$	217

In the same way , one can obtain $G_{22} \leq \left((\widehat{M}_{20})^{(3)}\right)_3 = G_{22}^0 + 2(a_{22})^{(3)}\left((\widehat{M}_{20})^{(3)}\right)_2/(a_{22}^{'})^{(3)}$ If G_{21} *or* G_{22} is bounded, the same property follows for G_{20} , G_{22} and G_{20} , G_{21} respectively.	
Remark 14: If G_{20} *is* bounded, from below, the same property holds for G_{21} *and* G_{22} . The proof is analogous with the preceding one. An analogous property is true if G_{21} is bounded from below.	218
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Then $\frac{dT_{21}}{dt} \geq (a_{21})^{(3)}(m)^{(3)} - \varepsilon_3 T_{21}$ which leads to $T_{21} \geq \left(\frac{(a_{21})^{(3)}(m)^{(3)}}{\varepsilon_3}\right)(1-e^{-\varepsilon_3 t}) + T_{21}^0 e^{-\varepsilon_3 t}$ If we take t such that $e^{-\varepsilon_3 t} = \frac{1}{2}$ it results $T_{21} \geq \left(\frac{(a_{21})^{(3)}(m)^{(3)}}{2}\right), \quad t = log\frac{2}{\varepsilon_3}$ By taking now ε_3 sufficiently small one sees that T_{21} is unbounded. The same property holds for T_{22} if $\lim_{t\to\infty}(b_{22}^{''})^{(3)}\left((G_{23})(t),t\right) = (b_{22}^{'})^{(3)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	220
It is now sufficient to take $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}$, $\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$ and to choose $(\widehat{P}_{24})^{(4)}$ and $(\widehat{Q}_{24})^{(4)}$ large to have	221
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$\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\left[((\widehat{Q}_{24})^{(4)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{24})^{(4)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{24})^{(4)}\right] \leq (\widehat{Q}_{24})^{(4)}$	223
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Indeed if we denote

Definition of $\widetilde{(G_{27})}, \widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})}, \widetilde{(T_{27})} \right) = \mathcal{A}^{(4)}((G_{27}), (T_{27}))$

It results

$$\left|\tilde{G}_{24}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{24})^{(4)} \left|G_{25}^{(1)} - G_{25}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \, ds_{(24)} +$$

$$\int_0^t \{(a'_{24})^{(4)} \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$(a''_{24})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right)\left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$G_{24}^{(2)} |(a''_{24})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right) - (a''_{24})^{(4)}\left(T_{25}^{(2)}, s_{(24)}\right)| \; e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}}\} ds_{(24)}$$

Where $s_{(24)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on Equations it follows

$$\left|(G_{27})^{(1)} - (G_{27})^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} t} \leq$$ 226

$$\frac{1}{(\widehat{M}_{24})^{(4)}} \left((a_{24})^{(4)} + (a'_{24})^{(4)} + (\widehat{A}_{24})^{(4)} + (\widehat{P}_{24})^{(4)} (\widehat{k}_{24})^{(4)} \right) d\left(\left((G_{27})^{(1)}, (T_{27})^{(1)}; \; (G_{27})^{(2)}, (T_{27})^{(2)} \right) \right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 16: The fact that we supposed $(a''_{24})^{(4)}$ and $(b''_{24})^{(4)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ *and* $(\widehat{Q}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ respectively of $\mathbb{R}_+$. 227

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(4)}$ and $(b''_i)^{(4)}, i = 24,25,26$ depend only on T_{25} and respectively on (G_{27}) *(and not on* t*)* and hypothesis can replaced by a usual Lipschitz condition.

Remark 17: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ 228

it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(4)} - (a''_i)^{(4)}(T_{25}(s_{(24)}), s_{(24)})\} ds_{(24)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b'_i)^{(4)} t)} > 0 \quad \text{for } \mathrm{t} > 0$$

Definition of $\left((\widehat{M}_{24})^{(4)}\right)_1, \left((\widehat{M}_{24})^{(4)}\right)_2$ *and* $\left((\widehat{M}_{24})^{(4)}\right)_3$: 229

Remark 18: if G_{24} is bounded, the same property have also G_{25} *and* G_{26} . indeed if

$G_{24} < (\widehat{M}_{24})^{(4)}$ it follows $\frac{dG_{25}}{dt} \leq \left((\widehat{M}_{24})^{(4)}\right)_1 - (a'_{25})^{(4)} G_{25}$ and by integrating

$$G_{25} \leq \left((\widehat{M}_{24})^{(4)}\right)_2 = G_{25}^0 + 2(a_{25})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_1 / (a'_{25})^{(4)}$$

In the same way , one can obtain $G_{26} \le \left((\widehat{M}_{24})^{(4)}\right)_3 = G_{26}^0 + 2(a_{26})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_2/(a'_{26})^{(4)}$ If G_{25} *or* G_{26} is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.	
Remark 19: If G_{24} *is* bounded, from below, the same property holds for G_{25} *and* G_{26} . The proof is analogous with the preceding one. An analogous property is true if G_{25} is bounded from below.	230
Remark 20: If T_{24} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(4)}((G_{27})(t),t)) = (b'_{25})^{(4)}$ then $T_{25} \to \infty$. **Definition of** $(m)^{(4)}$ and ε_4 : Indeed let t_4 be so that for $t > t_4$ $(b_{25})^{(4)} - (b_i'')^{(4)}((G_{27})(t),t) < \varepsilon_4, T_{24}(t) > (m)^{(4)}$	231
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Remark 36: The fact that we supposed $(a''_{40})^{(8)}$ and $(b''_{40})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ *and* $(\hat{Q}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(8)}$ and $(b''_i)^{(8)}, i=40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
Remark 37 There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$	275

it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(8)} - (a_i^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(8)} t)} > 0$ for $t > 0$	
Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}^{'})^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1 / (a_{41}^{'})^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2 / (a_{42}^{'})^{(8)}$ If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	276
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(8)}((G_{43})(t), t)) = (b_{41}^{'})^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i^{''})^{(8)}\left((G_{43})(t), t\right) < \varepsilon_8, T_{40}\,(t) > (m)^{(8)}$	278
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have	279 A

$$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)}+((\widehat{P}_{44})^{(9)}+G_j^0)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right]\leq(\widehat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[((\widehat{Q}_{44})^{(9)}+T_j^0)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)}+(\widehat{Q}_{44})^{(9)}\right]\leq(\widehat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right)=$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}|G_i^{(1)}(t)-G_i^{(2)}(t)|e^{-(\widehat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}|T_i^{(1)}(t)-T_i^{(2)}(t)|e^{-(\widehat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})},\widetilde{(T_{47})}:(\widetilde{(G_{47})},\widetilde{(T_{47})})=\mathcal{A}^{(9)}((G_{47}),(T_{47}))$
It results

$$|\tilde{G}_{44}^{(1)}-\tilde{G}_i^{(2)}|\leq\int_0^t(a_{44})^{(9)}|G_{45}^{(1)}-G_{45}^{(2)}|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}ds_{(44)}+$$
$$\int_0^t\{(a'_{44})^{(9)}|G_{44}^{(1)}-G_{44}^{(2)}|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}+$$
$$(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})|G_{44}^{(1)}-G_{44}^{(2)}|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}+$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})-(a''_{44})^{(9)}(T_{45}^{(2)},s_{(44)})|\ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)}-G^{(2)}|e^{-(\widehat{M}_{44})^{(9)}t}\leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)}+(a'_{44})^{(9)}+(\widehat{A}_{44})^{(9)}+(\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i=44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$

From 99 to 44 it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$	
Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$: **Remark 43:** if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if $G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating $G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$ In the same way , one can obtain $G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$ If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.	
Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.	
Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}\left((G_{47})(t), t\right)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i^{''})^{(9)}\left((G_{47})(t), t\right) < \varepsilon_9, T_{44}\,(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}\left((G_{47})(t), t\right) = (b_{46}^{'})^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$	280

$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
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and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}^{'})^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a_{15}^{'})^{(1)}t}] + G_{15}^0 e^{-(a_{15}^{'})^{(1)}t}\right)$	286

$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\big((G_{19}), t\big) - (b_{17}'')^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
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Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \le G_{16}(t) \le G_{16}^0 e^{(S_1)^{(2)} t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \le G_{17}(t) \le \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)} t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})}\left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)} t}\right] + G_{18}^0 e^{-(S_2)^{(2)} t} \le G_{18}(t) \le\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a'_{18})^{(2)})}\left[e^{(S_1)^{(2)} t} - e^{-(a'_{18})^{(2)} t}\right] + G_{18}^0 e^{-(a'_{18})^{(2)} t}\right)$	312
$T_{16}^0 e^{(R_1)^{(2)} t} \le T_{16}(t) \le T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)} t} \le T_{16}(t) \le \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b'_{18})^{(2)})}\left[e^{(R_1)^{(2)} t} - e^{-(b'_{18})^{(2)} t}\right] + T_{18}^0 e^{-(b'_{18})^{(2)} t} \le T_{18}(t) \le$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)} + (r_{16})^{(2)} + (R_2)^{(2)})}\left[e^{((R_1)^{(2)} + (r_{16})^{(2)})t} - e^{-(R_2)^{(2)} t}\right] + T_{18}^0 e^{-(R_2)^{(2)} t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)} (m_2)^{(2)} - (a'_{16})^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}^{'})^{(2)}$ $(R_2)^{(2)} = (b_{18}^{'})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} - (a_{20}^{''})^{(3)}(T_{21}, t) + (a_{21}^{''})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}, t) - (b_{21}^{''})^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
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and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},\ \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}\big((G_{27}), t\big) - (b_{25}'')^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations	329

$(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_1)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	
Definition of $(\bar{\nu}_1)^{(4)},,(\bar{\nu}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)}>0$, $(\bar{\nu}_2)^{(4)}<0$ and respectively $(\bar{u}_1)^{(4)}>0$, $(\bar{u}_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_2)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(\nu_0)^{(4)},(m_1)^{(4)}=(\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)}<(\nu_1)^{(4)}$ $(m_2)^{(4)}=(\nu_1)^{(4)},(m_1)^{(4)}=(\bar{\nu}_1)^{(4)}$, $\boldsymbol{if}\ (\nu_4)^{(4)}<(\nu_0)^{(4)}<(\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(\nu_4)^{(4)},(m_1)^{(4)}=(\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)}<(\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar{u}_1)^{(4)}$, $\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)}=\frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(u_0)^{(4)},\boldsymbol{if}\ (\bar{u}_1)^{(4)}<(u_0)^{(4)}$ where $(u_1)^{(4)},(\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t}\le G_{24}(t)\le G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}}G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t}\le G_{25}(t)\le\frac{1}{(m_2)^{(4)}}G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t}-e^{-(S_2)^{(4)}t}\right]+G_{26}^0 e^{-(S_2)^{(4)}t}\le G_{26}(t)\le\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t}\le T_{24}(t)\le T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}}$	
$\frac{1}{(\mu_1)^{(4)}}T_{24}^0 e^{(R_1)^{(4)}t}\le T_{24}(t)\le\frac{1}{(\mu_2)^{(4)}}T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}\left((R_1)^{(4)}-(b_{26}')^{(4)}\right)}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t}\le T_{26}(t)\le$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}')^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}')^{(4)}$ $(R_2)^{(4)}=(b_{26}')^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\le-(a_{28}')^{(5)}+(a_{29}')^{(5)}-(a_{28}'')^{(5)}(T_{29},t)+(a_{29}'')^{(5)}(T_{29},t)\le-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\le-(b_{28}')^{(5)}+(b_{29}')^{(5)}-(b_{28}'')^{(5)}((G_{31}),t)-(b_{29}'')^{(5)}((G_{31}),t)\le-(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},,(\bar{\nu}_2)^{(5)},(\bar{u}_1)^{(5)},(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)}>0,(\bar{\nu}_2)^{(5)}<0$ and respectively $(\bar{u}_1)^{(5)}>0,(\bar{u}_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar{\nu}_1)^{(5)},\boldsymbol{if}\ (\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}, \ \boldsymbol{if} \ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}, \boldsymbol{if} \ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if} \ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)} t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)} t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)} t}\right] + G_{30}^0 e^{-(S_2)^{(5)} t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b'_{30})^{(5)})}\left[e^{(R_1)^{(5)} t} - e^{-(b'_{30})^{(5)} t}\right] + T_{30}^0 e^{-(b'_{30})^{(5)} t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)} t}\right] + T_{30}^0 e^{-(R_2)^{(5)} t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a'_{28})^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b'_{28})^{(5)}$ $(R_2)^{(5)} = (b'_{30})^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \leq -(\tau_1)^{(6)}$	
<u>**Definition of**</u> $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
<u>**Definition of**</u> $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ <u>**Definition of**</u> $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)},\ \boldsymbol{if}\ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)},\ \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)}T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b'_{34})^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b'_{34})^{(6)}t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)}T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a'_{32})^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b'_{32})^{(6)}$ $(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}((G_{39}), t) - (b''_{37})^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
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Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
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$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}] + G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
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$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$ $(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$	
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
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and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
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$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
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Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}((G_{47}), t) - (b''_{45})^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

($\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0e^{-(S_2)^{(9)}t}\le G_{46}(t)\le$ $\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t}-e^{-(a_{46}')^{(9)}t}]+G_{46}^0e^{-(a_{46}')^{(9)}t}$)	
$\boxed{T_{44}^0e^{(R_1)^{(9)}t}\le T_{44}(t)\le T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}}T_{44}^0e^{(R_1)^{(9)}t}\le T_{44}(t)\le\frac{1}{(\mu_2)^{(9)}}T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b_{46}')^{(9)}t}\right]+T_{46}^0e^{-(b_{46}')^{(9)}t}\le T_{46}(t)\le$ $\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0e^{-(R_2)^{(9)}t}$	
Definition of $(S_1)^{(9)},(S_2)^{(9)},(R_1)^{(9)},(R_2)^{(9)}$:- Where $(S_1)^{(9)}=(a_{44})^{(9)}(m_2)^{(9)}-(a_{44}')^{(9)}$ $(S_2)^{(9)}=(a_{46})^{(9)}-(p_{46})^{(9)}$ $(R_1)^{(9)}=(b_{44})^{(9)}(\mu_2)^{(9)}-(b_{44}')^{(9)}$ $(R_2)^{(9)}=(b_{46}')^{(9)}-(r_{46})^{(9)}$	

Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have	386

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get 391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
<u>**Definition of**</u> $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain <u>**Definition of**</u> $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
<u>**Particular case :**</u> If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
<u>**Proof**</u> : From global equations we obtain	398

$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:-	403

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$ In a completely analogous way, we obtain **<u>Definition of</u>** $u^{(3)}(t)$:- $(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. <u>Particular case :</u> If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **<u>Definition of</u>** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **<u>Definition of</u>** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	405

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{5 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}}{1 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t)=(\nu_0)^{(5)}$ and as a consequence $G_{28}(t)=(\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)}=(b''_{29})^{(5)}, then\ (\tau_1)^{(5)}=(\tau_2)^{(5)}$ and then $(u_1)^{(5)}=(\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)}=(u_1)^{(5)}$ then $T_{28}(t)=(u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt}=(a_{32})^{(6)}-\left((a'_{32})^{(6)}-(a'_{33})^{(6)}+(a''_{32})^{(6)}(T_{33},t)\right)-(a''_{33})^{(6)}(T_{33},t)\nu^{(6)}-(a_{33})^{(6)}\nu^{(6)}$ **<u>Definition of</u>** $\nu^{(6)}$:- $\boxed{\nu^{(6)}=\frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$ From which one obtains **<u>Definition of</u>** $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:- For $0<\boxed{(\nu_0)^{(6)}=\frac{G^0_{32}}{G^0_{33}}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$	413
If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G^0_{32}}{G^0_{33}}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$ $\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$	414
If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G^0_{32}}{G^0_{33}}}$, we obtain $(\nu_1)^{(6)}\leq\ \nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G^0_{36}}{G^0_{37}}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:-	424

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>**Particular case :**</u>

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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<u>**Proof**</u> : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

<u>**Definition of**</u> $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

<u>**Definition of**</u> $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right) t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right) t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right) t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right) t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right) t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right) t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$,

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$

$with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i'')^{(2)} and\ (b_i'')^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}')^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}')^{(2)}(r_{17})^{(2)} - (b_{17}')^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i'')^{(3)} and\ (b_i'')^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}')^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}')^{(3)}(r_{21})^{(3)} - (b_{21}')^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i'')^{(4)} and\ (b_i'')^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}')^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}')^{(4)}(r_{25})^{(4)} - (b_{25}')^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i'')^{(5)} and\ (b_i'')^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}')^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}')^{(5)}(r_{29})^{(5)} - (b_{29}')^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i'')^{(6)} and\ (b_i'')^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}')^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}')^{(6)}(r_{33})^{(6)} - (b_{33}')^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25})\right]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27}))\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}((G_{27}))\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27}))\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}')^{(7)} - (b_{36}'')^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}')^{(7)} - (b_{37}'')^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}')^{(7)} - (b_{38}'')^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}')^{(8)} + (a_{41}'')^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}')^{(8)} - (b_{40}'')^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}')^{(8)} - (b_{41}'')^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}')^{(8)} - (b_{42}'')^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}')^{(9)} - (b_{44}'')^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}')^{(9)} - (b_{45}'')^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}')^{(9)} - (b_{46}'')^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}')^{(1)}(a_{14}'')^{(1)}(T_{14}) + (a_{14}')^{(1)}(a_{13}'')^{(1)}(T_{14}) + (a_{13}'')^{(1)}(T_{14})(a_{14}'')^{(1)}(T_{14}) = 0$	485
Proof: (o) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}')^{(2)}(a_{17}'')^{(2)}(T_{17}) + (a_{17}')^{(2)}(a_{16}'')^{(2)}(T_{17}) +$	486

$(a_{16}'')^{(2)}(T_{17})(a_{17}'')^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}')^{(3)}(a_{21}'')^{(3)}(T_{21}) + (a_{21}')^{(3)}(a_{20}'')^{(3)}(T_{21}) + (a_{20}'')^{(3)}(T_{21})(a_{21}'')^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}')^{(4)}(a_{25}'')^{(4)}(T_{25}) + (a_{25}')^{(4)}(a_{24}'')^{(4)}(T_{25}) + (a_{24}'')^{(4)}(T_{25})(a_{25}'')^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}')^{(5)}(a_{29}'')^{(5)}(T_{29}) + (a_{29}')^{(5)}(a_{28}'')^{(5)}(T_{29}) + (a_{28}'')^{(5)}(T_{29})(a_{29}'')^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}')^{(6)}(a_{33}'')^{(6)}(T_{33}) + (a_{33}')^{(6)}(a_{32}'')^{(6)}(T_{33}) + (a_{32}'')^{(6)}(T_{33})(a_{33}'')^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}')^{(7)}(a_{37}'')^{(7)}(T_{37}) + (a_{37}')^{(7)}(a_{36}'')^{(7)}(T_{37}) + (a_{36}'')^{(7)}(T_{37})(a_{37}'')^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}')^{(8)}(a_{41}'')^{(8)}(T_{41}) + (a_{41}')^{(8)}(a_{40}'')^{(8)}(T_{41}) + (a_{40}'')^{(8)}(T_{41})(a_{41}'')^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}')^{(9)}(a_{45}'')^{(9)}(T_{45}) + (a_{45}')^{(9)}(a_{44}'')^{(9)}(T_{45}) + (a_{44}'')^{(9)}(T_{45})(a_{45}'')^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*})=0$. With this value , we obtain from the three first equations $G_{13}=\frac{(a_{13})^{(1)}G_{14}}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^{*})]}$, $G_{15}=\frac{(a_{15})^{(1)}G_{14}}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*})=0$. With this value , we obtain from the three first equations	494
$G_{16}=\frac{(a_{16})^{(2)}G_{17}}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^{*})]}$, $G_{18}=\frac{(a_{18})^{(2)}G_{17}}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*})=0$. With this value , we obtain from the three first equations $G_{20}=\frac{(a_{20})^{(3)}G_{21}}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^{*})]}$, $G_{22}=\frac{(a_{22})^{(3)}G_{21}}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*})=0$. With this value , we obtain from the three first equations $G_{24}=\frac{(a_{24})^{(4)}G_{25}}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26}=\frac{(a_{26})^{(4)}G_{25}}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*})=0$. With this value , we obtain from the three first equations $G_{28}=\frac{(a_{28})^{(5)}G_{29}}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30}=\frac{(a_{30})^{(5)}G_{29}}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*})=0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right]+(b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right]+(b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23})=(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23})+(b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20},G_{21},G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27})=(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27})+(b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right]+(b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24},G_{25},G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31})=(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31})+(b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right]+(b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28},G_{29},G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35})=(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35})+(b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right]+(b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32},G_{33},G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*})=0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39})=(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39})+(b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right]+(b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36},G_{37},G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*})=0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi({G_{43}}^*) = 0$	
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}({G_{23}}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}({G_{23}}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^{*} given by $\varphi(G_{27})=0$, T_{25}^{*} given by $f(T_{25}^{*})=0$ and $G_{24}^{*}=\frac{(a_{24})^{(4)}G_{25}^{*}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26}^{*}=\frac{(a_{26})^{(4)}G_{25}^{*}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	516
$T_{24}^{*}=\frac{(b_{24})^{(4)}T_{25}^{*}}{[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}((G_{27})^{*})]}$, $T_{26}^{*}=\frac{(b_{26})^{(4)}T_{25}^{*}}{[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}((G_{27})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^{*} given by $\varphi((G_{31})^{*})=0$, T_{29}^{*} given by $f(T_{29}^{*})=0$ and $G_{28}^{*}=\frac{(a_{28})^{(5)}G_{29}^{*}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*}=\frac{(a_{30})^{(5)}G_{29}^{*}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	518
$T_{28}^{*}=\frac{(b_{28})^{(5)}T_{29}^{*}}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*}=\frac{(b_{30})^{(5)}T_{29}^{*}}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*})=0$, T_{33}^{*} given by $f(T_{33}^{*})=0$ and $G_{32}^{*}=\frac{(a_{32})^{(6)}G_{33}^{*}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*}=\frac{(a_{34})^{(6)}G_{33}^{*}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*}=\frac{(b_{32})^{(6)}T_{33}^{*}}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^{*})]}$, $T_{34}^{*}=\frac{(b_{34})^{(6)}T_{33}^{*}}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*})=0$, T_{37}^{*} given by $f(T_{37}^{*})=0$ and $G_{36}^{*}=\frac{(a_{36})^{(7)}G_{37}^{*}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}^{*}=\frac{(a_{38})^{(7)}G_{37}^{*}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$ $T_{36}^{*}=\frac{(b_{36})^{(7)}T_{37}^{*}}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^{*})]}$, $T_{38}^{*}=\frac{(b_{38})^{(7)}T_{37}^{*}}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*})=0$, T_{41}^{*} given by $f(T_{41}^{*})=0$ and $G_{40}^{*}=\frac{(a_{40})^{(8)}G_{41}^{*}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42}^{*}=\frac{(a_{42})^{(8)}G_{41}^{*}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}')^{(8)} - (b_{40}'')^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}')^{(8)} - (b_{42}'')^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial(a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial(b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}')^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}')^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}')^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}')^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}')^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(3)}$ *and* $(b_i'')^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{21}'')^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial(b_i'')^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}')^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}')^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}')^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}')^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b'_{21})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b'_{22})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(4)}$ *and* $(b''_i)^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial (b''_i)^{(5)}}{\partial G_j}(\,(G_{31})^{*}\,) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt}=-\left((a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\mathbb{G}_{28}+(a_{28})^{(5)}\mathbb{G}_{29}-(q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt}=-\left((a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)\mathbb{G}_{29}+(a_{29})^{(5)}\mathbb{G}_{28}-(q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt}=-\left((a_{30}^{'})^{(5)}+(p_{30})^{(5)}\right)\mathbb{G}_{30}+(a_{30})^{(5)}\mathbb{G}_{29}-(q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt}=-\left((b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)\mathbb{T}_{28}+(b_{28})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_{j}\right)$	560
$\frac{d\mathbb{T}_{29}}{dt}=-\left((b_{29}^{'})^{(5)}-(r_{29})^{(5)}\right)\mathbb{T}_{29}+(b_{29})^{(5)}\mathbb{T}_{28}+\sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_{j}\right)$	561
$\frac{d\mathbb{T}_{30}}{dt}=-\left((b_{30}^{'})^{(5)}-(r_{30})^{(5)}\right)\mathbb{T}_{30}+(b_{30})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_{j}\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i,\mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad ,T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*})=(q_{33})^{(6)} \quad , \frac{\partial(b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^{*}\,)=s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt}=-\left((a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\mathbb{G}_{32}+(a_{32})^{(6)}\mathbb{G}_{33}-(q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt}=-\left((a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)\mathbb{G}_{33}+(a_{33})^{(6)}\mathbb{G}_{32}-(q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt}=-\left((a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)\mathbb{G}_{34}+(a_{34})^{(6)}\mathbb{G}_{33}-(q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt}=-\left((b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)\mathbb{T}_{32}+(b_{32})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_{j}\right)$	568
$\frac{d\mathbb{T}_{33}}{dt}=-\left((b_{33}^{'})^{(6)}-(r_{33})^{(6)}\right)\mathbb{T}_{33}+(b_{33})^{(6)}\mathbb{T}_{32}+\sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_{j}\right)$	569
$\frac{d\mathbb{T}_{34}}{dt}=-\left((b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\mathbb{T}_{34}+(b_{34})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_{j}\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}\ and\ (b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}(\,(G_{43})^{*}\,) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T^*_{40}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T^*_{41}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T^*_{42}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(9)}$ *and* $(b''_i)^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **<u>Proof:</u>** **Denote**	586 A
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{45})^{(9)}}{\partial T_{45}}(T^*_{45}) = (q_{45})^{(9)} \quad , \frac{\partial (b''_i)^{(9)}}{\partial G_j}\left((G_{47})^*\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a'_{44})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G^*_{44}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a'_{45})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G^*_{45}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a'_{46})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G^*_{46}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b'_{44})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T^*_{44}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b'_{45})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T^*_{45}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b'_{46})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T^*_{46}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b'_{15})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a'_{15})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G^*_{14} + (a_{14})^{(1)}(q_{13})^{(1)}G^*_{13}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T^*_{14} + (b_{14})^{(1)}s_{(13),(14)}T^*_{14}\right)$ $+\left(\left((\lambda)^{(1)} + (a'_{14})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G^*_{13} + (a_{13})^{(1)}(q_{14})^{(1)}G^*_{14}\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T^*_{14} + (b_{14})^{(1)}s_{(13),(13)}T^*_{13}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$$

$$+\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right) \left((a_{15})^{(1)}(q_{14})^{(1)} G_{14}^{*} + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)} G_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right) s_{(14),(15)} T_{14}^{*} + (b_{14})^{(1)} s_{(13),(15)} T_{13}^{*}\right)\} = 0$$

$$+$$

$$\left((\lambda)^{(2)} + (b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\{\left((\lambda)^{(2)} + (a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)} + (a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)} \mathrm{G}_{17}^{*} + (a_{17})^{(2)}(q_{16})^{(2)} \mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right) s_{(17),(17)} \mathrm{T}_{17}^{*} + (b_{17})^{(2)} s_{(16),(17)} \mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)} + (a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)} \mathrm{G}_{16}^{*} + (a_{16})^{(2)}(q_{17})^{(2)} \mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right) s_{(17),(16)} \mathrm{T}_{17}^{*} + (b_{17})^{(2)} s_{(16),(16)} \mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right) (q_{18})^{(2)} \mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)} + (a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right) \left((a_{18})^{(2)}(q_{17})^{(2)} \mathrm{G}_{17}^{*} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)} \mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right) s_{(17),(18)} \mathrm{T}_{17}^{*} + (b_{17})^{(2)} s_{(16),(18)} \mathrm{T}_{16}^{*}\right)\} = 0$$

$$+$$

$$\left((\lambda)^{(3)} + (b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\{\left((\lambda)^{(3)} + (a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)} G_{21}^{*} + (a_{21})^{(3)}(q_{20})^{(3)} G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right) s_{(21),(21)} T_{21}^{*} + (b_{21})^{(3)} s_{(20),(21)} T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)} + (a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)} G_{20}^{*} + (a_{20})^{(3)}(q_{21})^{(1)} G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right) s_{(21),(20)} T_{21}^{*} + (b_{21})^{(3)} s_{(20),(20)} T_{20}^{*}\right)$$

$\left(\left((\lambda)^{(3)}\right)^2+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^*+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^*\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^*+(b_{21})^{(3)}s_{(20),(22)}T_{20}^*\right)\}=0$ +	
$\left((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^*+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^*\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^*+(b_{25})^{(4)}s_{(24),(25)}T_{25}^*\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^*+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^*\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^*+(b_{25})^{(4)}s_{(24),(24)}T_{24}^*\right)$ $\left(\left((\lambda)^{(4)}\right)^2+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2+\left((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^*+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^*\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^*+(b_{25})^{(4)}s_{(24),(26)}T_{24}^*\right)\}=0$ +	
$\left((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^*+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^*\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^*+(b_{29})^{(5)}s_{(28),(29)}T_{29}^*\right)$ $+\left(\left((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^*+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^*\right)$ $\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^*+(b_{29})^{(5)}s_{(28),(28)}T_{28}^*\right)$	

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right) (q_{30})^{(5)} G_{30}$$

$$+((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\} = 0$$

+

$$((\lambda)^{(6)} + (b_{34}^{'})^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a_{34}^{'})^{(6)} + (p_{34})^{(6)})$$

$$\left[\left(\left((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*} + (a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)} + (a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*} + (a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((b_{32}^{'})^{(6)} + (b_{33}^{'})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right) (q_{34})^{(6)} G_{34}$$

$$+((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)})\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\} = 0$$

+

$$((\lambda)^{(7)} + (b_{38}^{'})^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a_{38}^{'})^{(7)} + (p_{38})^{(7)})$$

$$\left[\left(\left((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)} + (a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*} + (a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}')^{(7)} + (a_{37}')^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}')^{(7)} + (b_{37}')^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}')^{(7)} + (a_{37}')^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)} + (a_{36}')^{(7)} + (p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^* + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^*\right)$$

$$\left(\left((\lambda)^{(7)} + (b_{36}')^{(7)} - (r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^* + (b_{37})^{(7)}s_{(36),(38)}T_{36}^*\right)\} = 0$$

$+$

$$\left((\lambda)^{(8)} + (b_{42}')^{(8)} - (r_{42})^{(8)}\right)\{\left((\lambda)^{(8)} + (a_{42}')^{(8)} + (p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)} + (a_{40}')^{(8)} + (p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^* + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^*\right)\right]$$

$$\left(\left((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^* + (b_{41})^{(8)}s_{(40),(41)}T_{41}^*\right)$$

$$+\left(\left((\lambda)^{(8)} + (a_{41}')^{(8)} + (p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^* + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^*\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^* + (b_{41})^{(8)}s_{(40),(40)}T_{40}^*\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}')^{(8)} + (a_{41}')^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}')^{(8)} + (b_{41}')^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}')^{(8)} + (a_{41}')^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)} + (a_{40}')^{(8)} + (p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^* + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^*\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^* + (b_{41})^{(8)}s_{(40),(42)}T_{40}^*\right)\} = 0$$

$+$

$$\left((\lambda)^{(9)} + (b_{46}')^{(9)} - (r_{46})^{(9)}\right)\{\left((\lambda)^{(9)} + (a_{46}')^{(9)} + (p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)} + (a_{44}')^{(9)} + (p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^* + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^*\right)\right]$$

$$\left(\left((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^* + (b_{45})^{(9)}s_{(44),(45)}T_{45}^*\right)$$

$$+\left(\left((\lambda)^{(9)} + (a_{45}')^{(9)} + (p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^* + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^*\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION SIXTEEN

Curved Non-Relativistic Spacetimes And Newtonian Gravitation

INTRODUCTION—VARIABLES USED

Curved non-relativistic spacetimes, Newtonian gravitation and massive matter Michael Geracie, Kartik Prabhu, Matthew M. Roberts

(1) There is significant recent work on coupling matter to (e&eb) Newton-Cartan spacetimes with (e&eb) the aim of investigating certain condensed matter phenomena.
(2) To this end, one needs to have (e) a completely general spacetime consistent with (e&eb) local non-relativistic symmetries which supports (eb) massive matter fields.
(3) In particular, one cannot impose (e&eb) a priori restrictions on (eb) the geometric data if (e) one wants to analyze matter response to (e) a perturbed geometry.
(4) In this paper authors construct such a Bargmann spacetime in (eb) complete generality without (e) any prior restrictions on (eb) the fields specifying the geometry.
(5) The resulting spacetime structure includes (e) the familiar Newton-Cartan structure with (e&eb) an additional gauge field which couples to (e&eb) mass.
(6) Authors illustrate the matter coupling with a few examples. The general spacetime constructed also includes (e) as a special case the covariant description of (e) Newtonian gravity, which has been thoroughly investigated in previous works.
(7) They also show how our Bargmann spacetimes arise from (e) a suitable non-relativistic limit of (e) Lorentzian spacetimes.
(8) In a companion paper [arXiv: 1503.02680] authors use this Bargmann spacetime structure to (e)

investigate the details of matter couplings, including (e) the Noether-Ward identities, and transport phenomena and (e&eb) thermodynamics of non-relativistic fluids.

(9) Comments: v5: update references matches version published in JMP v4: minor text changes. Version accepted in Journal of Mathematical Physics v3: improved discussion of NR limit and added refs, v2: updated references and text. v1: 39 pages, 2 figures Subjects: High Energy Physics - Theory (hep-th); General Relativity and Quantum Cosmology (gr-qc); Mathematical Physics (math-ph) Journal reference: J. Math. Phys. 56, 103505 (2015) DOI: 10.1063/1.4932967 Report number: EFI-15-14 Cite as: arXiv: 1503.02682 [hep-th] (or arXiv: 1503.02682v5 [hep-th] for this version)

NOTATION

Module One

Fields and fluids on curved non-relativistic spacetimes Michael Geracie, Kartik Prabhu, Matthew M. Roberts

(1) Kubo formulas for all response coefficients are presented. Approach also immediately generalizes (eb) to systems with (e&eb) independent mass and charge currents as would arise (eb) in multicomponent fluids.

(2) Along the way authors also discuss how to write general locally Galilean invariant non-relativistic actions for (e) multiple particle species at any order in derivatives. A detailed review of the geometry and its relation to (e&eb) non-relativistic limits may be found in a companion paper [arXiv: 1503.02682]. Subjects: High Energy Physics - Theory (hep-th); Mesoscale and Nanoscale Physics (cond-mat.mes-hall) journal reference: JHEP 08 (2015) 042 DOI: 10.1007/JHEP08 (2015)042 Report number: EFI-15-13 Cite as: arXiv:1503.02680 [hep-th] (or arXiv:1503.02680v6 [hep-th] for this version)

G_{13} : Category one of **Approach also immediately generalizes;** systems with (e&eb) independent mass and charge currents as would arise (eb) in multicomponent fluids.

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of systems with (e&eb) independent mass and charge currents as would arise (eb) in multicomponent fluids; **Approach also immediately generalizes**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Kubo formulas for all response coefficients are presented. Approach also immediately generalizes (eb) to systems with independent mass and charge currents as would arise (eb) in multicomponent fluids

G_{16} : Category one of **multicomponent fluids;** independent mass and charge currents

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of independent mass and charge currents; **multicomponent fluids** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three geometry and its relation to (e&eb) non-relativistic limits	
G_{20} : Category one of **geometry;** non-relativistic limits G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of non-relativistic limits **;geometry** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four There is significant recent work on coupling matter to (e&eb) Newton-Cartan spacetimes with (e&eb) the aim of investigating certain condensed matter phenomena	
G_{24} : Category one of **matter;** Newton-Cartan spacetimes with (e&eb) the aim of investigating certain condensed matter phenomena G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of Newton-Cartan spacetimes with (e&eb) the aim of investigating certain condensed matter phenomena **;matter** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five There is significant recent work on coupling matter to Newton-Cartan spacetimes with (e&eb) the aim of investigating certain condensed matter phenomena	
G_{28} : Category one of **coupling matter to Newton-Cartan spacetimes;** aim of investigating certain condensed matter phenomena G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of aim of investigating certain condensed matter phenomena **;coupling matter to Newton-Cartan spacetimes**	

T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six To this end, one needs to have (e) a completely general spacetime consistent with (e&eb) local non-relativistic symmetries which supports (eb) massive matter fields	
G_{32} : Category one of **completely general spacetime;** local non-relativistic symmetries which supports (eb) massive matter fields G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of local non-relativistic symmetries which supports (eb) massive matter fields **;completely general spacetime** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven To this end, one needs to have a completely general spacetime consistent with local non-relativistic symmetries which supports (eb) massive matter fields	
G_{36} : Category one of **completely general spacetime consistent with local non-relativistic symmetries;** massive matter fields G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of massive matter fields **;completely general spacetime consistent with local non-relativistic symmetries** T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight In particular, one cannot impose a priori restrictions on (eb) the geometric data if (e) one wants to analyze matter response to (e) a perturbed geometry	
G_{40} : Category one of **one cannot impose a priori restrictions;** geometric data if (e) one wants to analyze matter response to (e) a perturbed geometry G_{41} : Category two of SAS	

G_{42} : Category three of SAS	
T_{40} : Category one of geometric data if (e) one wants to analyze matter response to (e) a perturbed geometry **;one cannot impose a priori restrictions** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine In particular, one cannot impose a priori restrictions on the geometric data if (e) one wants to analyze matter response to (e) a perturbed geometry	
G_{44} : Category one of one wants to analyze matter response to (e) a perturbed geometry G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of one cannot impose a priori restrictions on the geometric data T_{45} : Category two of SAS T_{46} : Category three of SAS	

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	

Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14},t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14},t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14},t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G,t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G,t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G,t) \right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17},t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17},t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17},t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}),t\right) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}),t\right) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}),t\right) \right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t) \right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t) \right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t) \right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23},t) \right] T_{22}$	18
$+(a''_{20})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t) \right] G_{24}$	19

$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25}, t)\right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}, t)\right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)}\left((G_{27}), t\right)\right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)}\left((G_{27}), t\right)\right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b_{26}')^{(4)} - (b_{26}'')^{(4)}\left((G_{27}), t\right)\right] T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25}, t) =$ **First augmentation factor**	
$-(b_{24}'')^{(4)}\left((G_{27}), t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}, t)\right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29}, t)\right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}, t)\right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b_{28}')^{(5)} - (b_{28}'')^{(5)}\left((G_{31}), t\right)\right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b_{29}')^{(5)} - (b_{29}'')^{(5)}\left((G_{31}), t\right)\right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b_{30}')^{(5)} - (b_{30}'')^{(5)}\left((G_{31}), t\right)\right] T_{30}$	30
$+(a_{28}'')^{(5)}(T_{29}, t) =$ **First augmentation factor**	
$-(b_{28}'')^{(5)}\left((G_{31}), t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}, t)\right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33}, t)\right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}, t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}')^{(6)} - (b_{32}'')^{(6)}\left((G_{35}), t\right)\right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}')^{(6)} - (b_{33}'')^{(6)}\left((G_{35}), t\right)\right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}')^{(6)} - (b_{34}'')^{(6)}\left((G_{35}), t\right)\right] T_{34}$	36
$+(a_{32}'')^{(6)}(T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}, t)\right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37}, t)\right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}, t)\right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}')^{(7)} - (b_{36}'')^{(7)}\left((G_{39}), t\right)\right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}')^{(7)} - (b_{37}'')^{(7)}\left((G_{39}), t\right)\right] T_{37}$	*41*

$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}')^{(7)} - (b_{38}'')^{(7)}\left((G_{39}),t\right)\right] T_{38}$	42
$+(a_{36}'')^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}')^{(8)} + (a_{41}'')^{(8)}(T_{41},t)\right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41},t)\right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}')^{(8)} - (b_{40}'')^{(8)}\left((G_{43}),t\right)\right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}')^{(8)} - (b_{41}'')^{(8)}\left((G_{43}),t\right)\right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}')^{(8)} - (b_{42}'')^{(8)}\left((G_{43}),t\right)\right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45},t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45},t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45},t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}')^{(9)} - (b_{44}'')^{(9)}\left((G_{47}),t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}')^{(9)} - (b_{45}'')^{(9)}\left((G_{47}),t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}')^{(9)} - (b_{46}'')^{(9)}\left((G_{47}),t\right)\right] T_{46}$	54
$+(a_{44}'')^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b_{44}'')^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a_{13}')^{(1)} \boxed{+(a_{13}'')^{(1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a_{14}')^{(1)} \boxed{+(a_{14}'')^{(1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{37}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a_{15}')^{(1)} \boxed{+(a_{15}'')^{(1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$	57
Where $\boxed{(a_{13}'')^{(1)}(T_{14},t)}$, $\boxed{(a_{14}'')^{(1)}(T_{14},t)}$, $\boxed{(a_{15}'')^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}'')^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b_{13}^{'})^{(1)} \boxed{-(b_{13}^{''})^{(1)}(G,t)} \boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{36}^{''})^{(7,7,)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8)}(G_{43},t)} \boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b_{14}^{'})^{(1)} \boxed{-(b_{14}^{''})^{(1)}(G,t)} \boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{37}^{''})^{(7,7,)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8)}(G_{43},t)} \boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b_{15}^{'})^{(1)} \boxed{-(b_{15}^{''})^{(1)}(G,t)} \boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8)}(G_{43},t)} \boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	*60*
Where $\boxed{-(b_{13}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}^{''})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{40}^{''})^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{41}^{''})^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{42}^{''})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a'_{16})^{(2)}\boxed{+(a''_{16})^{(2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{16}$	*61*
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a'_{17})^{(2)}\boxed{+(a''_{17})^{(2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	*62*
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a'_{18})^{(2)}\boxed{+(a''_{18})^{(2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	*63*
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,)}(G,t)}\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16}$	*64*
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,)}(G,t)}\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17}$	*65*

$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[\begin{matrix}(b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,)}(G,t)}\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\left[\begin{matrix}(a'_{20})^{(3)}\boxed{+(a''_{20})^{(3)}(T_{21},t)}\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}\end{matrix}\right]G_{20}$	67
$\frac{dG_{21}}{dt}=(a_{21})^{(3)}G_{20}-\left[\begin{matrix}(a'_{21})^{(3)}\boxed{+(a''_{21})^{(3)}(T_{21},t)}\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}\end{matrix}\right]G_{21}$	68
$\frac{dG_{22}}{dt}=(a_{22})^{(3)}G_{21}-\left[\begin{matrix}(a'_{22})^{(3)}\boxed{+(a''_{22})^{(3)}(T_{21},t)}\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}\end{matrix}\right]G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3	

$+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3

$+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3

$+(a''_{40})^{(8,8,8,8)}(T_{41},t)$,$+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3

$+(a''_{44})^{(9,9,9)}(T_{45},t)$,$+(a''_{45})^{(9,9,9)}(T_{45},t)$,$+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b'_{20})^{(3)} -(b''_{20})^{(3)}(G_{23},t) - (b''_{16})^{(2,2,2)}(G_{19},t) - (b''_{13})^{(1,1,1,)}(G,t) \\ -(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{28})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{32})^{(6,6,6,6,6,6)}(G_{35},t) \\ - (b''_{36})^{(7,7,7,7)}(G_{39},t) - (b''_{40})^{(8,8,8,8)}(G_{43},t) - (b''_{44})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} -(b''_{21})^{(3)}(G_{23},t) - (b''_{17})^{(2,2,2)}(G_{19},t) - (b''_{14})^{(1,1,1,)}(G,t) \\ -(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{29})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{33})^{(6,6,6,6,6,6)}(G_{35},t) \\ - (b''_{37})^{(7,7,7,7)}(G_{39},t) - (b''_{41})^{(8,8,8,8)}(G_{43},t) - (b''_{45})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} -(b''_{22})^{(3)}(G_{23},t) - (b''_{18})^{(2,2,2)}(G_{19},t) - (b''_{15})^{(1,1,1,)}(G,t) \\ -(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{30})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{34})^{(6,6,6,6,6,6)}(G_{35},t) \\ - (b''_{38})^{(7,7,7,7)}(G_{39},t) - (b''_{42})^{(8,8,8,8)}(G_{43},t) - (b''_{46})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{22} \quad 72$$

$-(b''_{20})^{(3)}(G_{23},t)$, $-(b''_{21})^{(3)}(G_{23},t)$, $-(b''_{22})^{(3)}(G_{23},t)$ *are first detrition coefficients for category 1, 2 and 3*

$-(b''_{16})^{(2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2)}(G_{19},t)$ *are second detrition coefficients for category 1, 2 and 3*

$-(b''_{13})^{(1,1,1,)}(G,t)$, $-(b''_{14})^{(1,1,1,)}(G,t)$, $-(b''_{15})^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3*

$-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3*

$-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3*

$-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3*

$-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$ $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8,8,8)}(G_{43},t)$,$-(b''_{41})^{(8,8,8,8)}(G_{43},t)$,$-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\left[(a'_{24})^{(4)}+(a''_{24})^{(4)}(T_{25},t)+(a''_{28})^{(5,5,)}(T_{29},t)+(a''_{32})^{(6,6,)}(T_{33},t)+(a''_{13})^{(1,1,1,1)}(T_{14},t)+(a''_{16})^{(2,2,2,2)}(T_{17},t)+(a''_{20})^{(3,3,3,3)}(T_{21},t)+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)+(a''_{44})^{(9,9,9,9)}(T_{45},t)\right]G_{24}$	73
$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\left[(a'_{25})^{(4)}+(a''_{25})^{(4)}(T_{25},t)+(a''_{29})^{(5,5,)}(T_{29},t)+(a''_{33})^{(6,6)}(T_{33},t)+(a''_{14})^{(1,1,1,1)}(T_{14},t)+(a''_{17})^{(2,2,2,2)}(T_{17},t)+(a''_{21})^{(3,3,3,3)}(T_{21},t)+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)+(a''_{45})^{(9,9,9,9)}(T_{45},t)\right]G_{25}$	74
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\left[(a'_{26})^{(4)}+(a''_{26})^{(4)}(T_{25},t)+(a''_{30})^{(5,5,)}(T_{29},t)+(a''_{34})^{(6,6,)}(T_{33},t)+(a''_{15})^{(1,1,1,1)}(T_{14},t)+(a''_{18})^{(2,2,2,2)}(T_{17},t)+(a''_{22})^{(3,3,3,3)}(T_{21},t)+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)+(a''_{46})^{(9,9,9,9)}(T_{45},t)\right]G_{26}$	75
$(a''_{24})^{(4)}(T_{25},t)$, $(a''_{25})^{(4)}(T_{25},t)$, $(a''_{26})^{(4)}(T_{25},t)$ *are first augmentation coefficients category* 1, 2 3 $+(a''_{28})^{(5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{32})^{(6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{13})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1)}(T_{14},t)$ *are fourth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{16})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2)}(T_{17},t)$ *are fifth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{20})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3)}(T_{21},t)$ *are sixth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$ *are seventh augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)$ *are eighth augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{46})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9)}(T_{45},t)$ are ninth detrition coefficients for category 1 2 3	
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[(b'_{24})^{(4)}-(b''_{24})^{(4)}(G_{27},t)-(b''_{28})^{(5,5,)}(G_{31},t)-(b''_{32})^{(6,6,)}(G_{35},t)-(b''_{13})^{(1,1,1,1)}(G,t)-(b''_{16})^{(2,2,2,2)}(G_{19},t)-(b''_{20})^{(3,3,3,3)}(G_{23},t)-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)-(b''_{44})^{(9,9,9,9)}(G_{47},t)\right]T_{24}$	76
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\left[(b'_{25})^{(4)}-(b''_{25})^{(4)}(G_{27},t)-(b''_{29})^{(5,5,)}(G_{31},t)-(b''_{33})^{(6,6,)}(G_{35},t)-(b''_{14})^{(1,1,1,1)}(G,t)-(b''_{17})^{(2,2,2,2)}(G_{19},t)-(b''_{21})^{(3,3,3,3)}(G_{23},t)-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)-(b''_{45})^{(9,9,9,9)}(G_{47},t)\right]T_{25}$	77

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$
are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$
are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$
are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$
are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$
are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28} \quad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29} \quad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30} \quad 81$$

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[\begin{matrix}(b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\ \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{28}$	82
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[\begin{matrix}(b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\ \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{29}$	83
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[\begin{matrix}(b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\ \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{30}$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3	

$\boxed{-(b_{46}'')^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a_{32}')^{(6)} \boxed{+(a_{32}'')^{(6)}(T_{33},t)} \boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32} \quad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a_{33}')^{(6)} \boxed{+(a_{33}'')^{(6)}(T_{33},t)} \boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a_{34}')^{(6)} \boxed{+(a_{34}'')^{(6)}(T_{33},t)} \boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34} \quad 87$$

$\boxed{+(a_{32}'')^{(6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a_{16}'')^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a_{20}'')^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b_{32}')^{(6)} \boxed{-(b_{32}'')^{(6)}(G_{35},t)} \boxed{-(b_{28}'')^{(5,5,5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33}$$	89
$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34}$$	90

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$$ 91

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$$ 92

$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	93
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} =$$

$$(b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3	

$+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ are Seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$ $+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$ $+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$ are eighth augmentation coefficient for 1,2,3 $+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b'_{44})^{(9)} -(b''_{44})^{(9)}(G_{47},t) -(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t) -(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t) -(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t) \end{matrix} \right] T_{13}$	
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b'_{45})^{(9)} -(b''_{45})^{(9)}(G_{47},t) -(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t) -(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t) -(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t) -(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t) -(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t) -(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t) \end{matrix} \right] T_{14}$	
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)} -(b''_{46})^{(9)}(G_{47},t) -(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t) -(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t) -(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t) -(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t) -(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t) -(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t) \end{matrix} \right] T_{15}$	
Where $-(b''_{44})^{(9)}(G_{47},t)$, $-(b''_{45})^{(9)}(G_{47},t)$, $-(b''_{46})^{(9)}(G_{47},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3 $-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)$ are seventh detrition coefficients for category 1, 2 and 3	

$-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)},(a_i')^{(1)},(a_i'')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(b_i'')^{(1)}>0, \quad i,j=13,14,15$ The functions $(a_i'')^{(1)},(b_i'')^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i'')^{(1)}(T_{14},t)\le(p_i)^{(1)}\le(\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t)\le \ (r_i)^{(1)}\le(b_i')^{(1)}\le(\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t)=(p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t)= \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}$ are positive constants and $i=13,14,15$	98
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\rvert\le(\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\rvert<(\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\lvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \ ,\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}, i=13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i^{'})^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i^{'})^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	
Where we suppose	
$(a_i)^{(2)},(a_i^{'})^{(2)},(a_i^{''})^{(2)},(b_i)^{(2)},(b_i^{'})^{(2)},(b_i^{''})^{(2)}>0, \quad i,j=16,17,18$	
The functions $(a_i^{''})^{(2)},(b_i^{''})^{(2)}$ are positive continuous increasing and bounded.	
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$(a_i^{''})^{(2)}(T_{17},t)\leq(p_i)^{(2)}\leq(\hat{A}_{16})^{(2)}$	102
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$\lim_{G\to\infty}(b_i^{''})^{(2)}\big((G_{19}),t\big)= (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)}, (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(2)}(T_{17}^{'},t)-(a_i^{''})^{(2)}(T_{17},t)\rvert\leq(\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}^{'}\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i^{''})^{(2)}((G_{19})^{'},t)-(b_i^{''})^{(2)}\big((G_{19}),t\big)\rvert<(\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})^{'}\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'},t)$ and$(a_i^{''})^{(2)}(T_{17},t)$. $(T_{17}^{'},t)$ and (T_{17},t) are points belonging to the interval $\big[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\big]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i^{''})^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)}$ *and* $(\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i^{'})^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\,(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i^{'})^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty}(a_i^{''})^{(3)}\,(T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty}(b_i^{''})^{(3)}\,(G_{23}, t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\|(a_i^{''})^{(3)}(T_{21}^{'}, t) - (a_i^{''})^{(3)}(T_{21}, t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}^{'}\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i^{''})^{(3)}(G_{23}{'}, t) - (b_i^{''})^{(3)}(G_{23}, t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}{'}\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and $(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)},$ are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}\ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25}, t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}), t) \leq (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2 \to \infty} (a_i^{''})^{(4)} (T_{25}, t) = (p_i)^{(4)}$ $\lim_{G \to \infty} (b_i^{''})^{(4)} ((G_{27}), t) = (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	118
They satisfy Lipschitz condition: $\|(a_i^{''})^{(4)}(T_{25}^{'}, t) - (a_i^{''})^{(4)}(T_{25}, t)\| \leq (\hat{k}_{24})^{(4)}\|T_{25} - T_{25}^{'}\|e^{-(\hat{M}_{24})^{(4)}t}$ $\|(b_i^{''})^{(4)}((G_{27})^{'}, t) - (b_i^{''})^{(4)}((G_{27}), t)\| < (\hat{k}_{24})^{(4)}\|\|(G_{27}) - (G_{27})^{'}\|\|e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'}, t)$ and $(a_i^{''})^{(4)}(T_{25}, t)$. $(T_{25}^{'}, t)$ and (T_{25}, t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)},$ are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26$, satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i')^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i')^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i')^{(5)}, (a_i'')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (b_i'')^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i'')^{(5)}, (b_i'')^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29}, t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}), t) \leq (r_i)^{(5)} \leq (b_i')^{(5)} \leq (\hat{B}_{28})^{(5)}$	122
$lim_{T_2 \to \infty}(a_i'')^{(5)}(T_{29}, t) = (p_i)^{(5)}$ $\lim_{G \to \infty}(b_i'')^{(5)}(G_{31}, t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\|(a_i'')^{(5)}(T_{29}', t) - (a_i'')^{(5)}(T_{29}, t)\| \leq (\hat{k}_{28})^{(5)}\|T_{29} - T_{29}'\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i'')^{(5)}((G_{31})', t) - (b_i'')^{(5)}((G_{31}), t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31}) - (G_{31})'\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}', t)$ and $(a_i'')^{(5)}(T_{29}, t)$. (T_{29}', t) and (T_{29}, t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i'')^{(5)}(T_{29}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}$, $\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$

Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: 126

There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)}$ and $(\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$$

$$\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$$

Where we suppose

$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ 127

The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(6)}, (r_i)^{(6)}$:

$$(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$$

$$(b_i'')^{(6)}((G_{35}), t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$$

$$lim_{T_2 \to \infty}(a_i'')^{(6)}(T_{33}, t) = (p_i)^{(6)}$$ 128

$$\lim_{G \to \infty}(b_i'')^{(6)}\left((G_{35}), t\right) = (r_i)^{(6)}$$

Definition of $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$:

Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$

They satisfy Lipschitz condition:

$$|(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)| \leq (\hat{k}_{32})^{(6)}|T_{33} - T_{33}'|e^{-(\hat{M}_{32})^{(6)}t}$$

$$|(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}\left((G_{35}), t\right)| < (\hat{k}_{32})^{(6)}||(G_{35}) - (G_{35})'||e^{-(\hat{M}_{32})^{(6)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: 129

$(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}, \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and\ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(MMMM) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (NNNN)The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(OOOO) $\lim_{T_2\to\infty} (a_i'')^{(7)}(T_{37}, t) = (p_i)^{(7)}$ *(PPPP)* $\lim_{G\to\infty} (b_i'')^{(7)}((G_{39}), t) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (QQQQ) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (RRRR) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and\ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}), t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2 \to \infty} (a_i'')^{(8)}(T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G \to \infty} (b_i'')^{(8)}\left((G_{43}), t\right) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}', t) - (a_i'')^{(8)}(T_{41}, t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142

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Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
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$\frac{1}{(\hat{M}_{40})^{(8)}}[\,(a_i)^{(8)}+(a_i')^{(8)}+\ (\hat{A}_{40})^{(8)}+\ (\hat{P}_{40})^{(8)}\ (\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[\ (b_i)^{(8)}+(b_i')^{(8)}+\ (\hat{B}_{40})^{(8)}+\ (\hat{Q}_{40})^{(8)}\ \ (\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)}>0,\qquad i,j=44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)},\ (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t)\le(p_i)^{(9)}\le(\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t)\le\ (r_i)^{(9)}\le(b_i')^{(9)}\le(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}\,(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}\,(G_{47},t)=\ (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition:	

$\lvert(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)\rvert \leq (\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}'\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)\rvert < (\hat{k}_{44})^{(9)}\lvert\lvert(G_{47})-(G_{47})'\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and$(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(p_i)^{(9)},(r_i)^{(9)},i=44,45,46,$ satisfy the inequalities $\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i')^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i')^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0),T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0)=G_i^0>0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0)=T_i^0>0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0),T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0)=G_i^0>0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0)=T_i^0>0$	148
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$T_i(t) \leq \ (\hat{Q}_{20}\ )^{(3)} e^{(\hat{M}_{20}\ )^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\ ,T_i(0)$: $G_i(t) \leq \ (\ \hat{P}_{24}\ )^{(4)} e^{(\hat{M}_{24}\ )^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24}\ )^{(4)} e^{(\hat{M}_{24}\ )^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
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Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\ ,T_i(0)$: $G_i(t) \leq \ (\ \hat{P}_{32}\ )^{(6)} e^{(\hat{M}_{32}\ )^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{32}\ )^{(6)} e^{(\hat{M}_{32}\ )^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
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$G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$,$T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{13}\left(s_{(13)}\right) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}\left(s_{(13)}\right) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{14}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{15}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}\left(s_{(13)}\right) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)} \left(G\left(s_{(13)}\right), s_{(13)}\right) \right) T_{13}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}\left(s_{(13)}\right) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)} \left(G\left(s_{(13)}\right), s_{(13)}\right) \right) T_{14}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}\left(s_{(13)}\right) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)} \left(G\left(s_{(13)}\right), s_{(13)}\right) \right) T_{15}\left(s_{(13)}\right) \right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
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$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$,$T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)} \left(T_{17}\left(s_{(16)}\right), s_{(16)}\right) \right) G_{16}\left(s_{(16)}\right) \right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}\left(s_{(16)}\right) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)} \left(T_{17}\left(s_{(16)}\right), s_{(17)}\right) \right) G_{17}\left(s_{(16)}\right) \right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \leq (\hat{P}_{20})^{(3)},\ T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \leq (\hat{P}_{24})^{(4)},\ T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{28})^{(5)}, T_i^0 \le (\hat{Q}_{28})^{(5)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} \, , T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i \, , \, T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{36} \,)^{(7)} \, , T_i^0 \leq (\, \hat{Q}_{36} \,)^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{36} \,)^{(7)} e^{(\, \hat{M}_{36} \,)^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{36} \,)^{(7)} e^{(\, \hat{M}_{36} \,)^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}')^{(7)} - (b_{37}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}')^{(7)} - (b_{38}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{40})^{(8)}, T_i^0 \le (\hat{Q}_{40})^{(8)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}')^{(8)} + a_{40}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}')^{(8)} + (a_{41}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}')^{(8)} + (a_{42}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}')^{(8)} - (b_{40}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}')^{(8)} - (b_{41}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}')^{(8)} - (b_{42}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{44})^{(9)}, T_i^0 \le (\hat{Q}_{44})^{(9)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[((\hat{P}_{13})^{(1)} + G_{14}^0) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $(1 + (a_{16})^{(2)} t) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[((\hat{P}_{16})^{(2)} + G_{17}^0) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1\right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0\right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0}\right)} + (\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}}\right)\right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1\right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0) e^{-(\hat{M}_{24})^{(4)} t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left[\left((\hat{P}_{24})^{(4)} + G_{25}^0\right) e^{\left(-\frac{(\hat{P}_{24})^{(4)} + G_{25}^0}{G_{25}^0}\right)} + (\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}}\right)\right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1\right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0\right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0}\right)} + (\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}}\right)\right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1\right)$	176

From which it follows that $(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[((\hat{P}_{32})^{(6)}+G_{33}^0)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(p) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0+\int_0^t\left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right]ds_{(36)} =$ $(1+(a_{36})^{(7)}t)G_{37}^0+\frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$	178
From which it follows that $(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[((\hat{P}_{36})^{(7)}+G_{37}^0)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0+\int_0^t\left[(a_{40})^{(8)}\left(G_{41}^0+(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right]ds_{(40)} =$ $(1+(a_{40})^{(8)}t)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	180
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{P}_{40})^{(8)}+G_{41}^0)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0+\int_0^t\left[(a_{44})^{(9)}\left(G_{45}^0+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right]ds_{(44)} =$ $(1+(a_{44})^{(9)}t)G_{45}^0+\frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$	
From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{P}_{44})^{(9)}+G_{45}^0)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$	

(G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45} , $G_{46}, T_{44}, T_{45}, T_{46}$	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)} + ((\hat{P}_{13})^{(1)} + G_j^0)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[((\hat{Q}_{13})^{(1)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{13})^{(1)}\right] \leq (\hat{Q}_{13})^{(1)}$	184
In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left((G^{(1)}, T^{(1)}), (G^{(2)}, T^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \|G_i^{(1)}(t) - G_i^{(2)}(t)\| e^{-(\hat{M}_{13})^{(1)}t}, \max_{t\in\mathbb{R}_+} \|T_i^{(1)}(t) - T_i^{(2)}(t)\| e^{-(\hat{M}_{13})^{(1)}t}\}$	185
Indeed if we denote **Definition of** $\tilde{G}, \tilde{T}$: $(\tilde{G}, \tilde{T}) = \mathcal{A}^{(1)}(G, T)$ It results $\|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\| \leq \int_0^t (a_{13})^{(1)} \|G_{14}^{(1)} - G_{14}^{(2)}\| e^{-(\hat{M}_{13})^{(1)} s_{(13)}} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\, ds_{(13)} +$ $\int_0^t \{(a'_{13})^{(1)} \|G_{13}^{(1)} - G_{13}^{(2)}\| e^{-(\hat{M}_{13})^{(1)} s_{(13)}} e^{-(\hat{M}_{13})^{(1)} s_{(13)}} +$ $(a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) \|G_{13}^{(1)} - G_{13}^{(2)}\| e^{-(\hat{M}_{13})^{(1)} s_{(13)}} e^{(\hat{M}_{13})^{(1)} s_{(13)}} +$ $G_{13}^{(2)} \|(a''_{13})^{(1)}(T_{14}^{(1)}, s_{(13)}) - (a''_{13})^{(1)}(T_{14}^{(2)}, s_{(13)})\|\ e^{-(\hat{M}_{13})^{(1)} s_{(13)}} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\} ds_{(13)}$ Where $s_{(13)}$ represents integrand that is integrated over the interval $[0, t]$ From the hypotheses it follows	
$\|G^{(1)} - G^{(2)}\| e^{-(\hat{M}_{13})^{(1)}t} \leq$ $\frac{1}{(\hat{M}_{13})^{(1)}}\left((a_{13})^{(1)} + (a'_{13})^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}\right) d\left((G^{(1)}, T^{(1)};\ G^{(2)}, T^{(2)})\right)$	186

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	
Remark 1: The fact that we supposed $(a''_{13})^{(1)}$ and $(b''_{13})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$ *and* $(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(1)}$ and $(b''_i)^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(\text{and not on } t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 2: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ From 19 to 24 it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t\{(a'_i)^{(1)}-(a''_i)^{(1)}(T_{14}(s_{(13)}),s_{(13)})\}ds_{(13)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b'_i)^{(1)}t)} > 0$ for t > 0	
Definition of $\left((\hat{M}_{13})^{(1)}\right)_1, \left((\hat{M}_{13})^{(1)}\right)_2$ *and* $\left((\hat{M}_{13})^{(1)}\right)_3$: **Remark 3:** if G_{13} is bounded, the same property have also G_{14} *and* G_{15} . indeed if $G_{13} < (\hat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \leq \left((\hat{M}_{13})^{(1)}\right)_1 - (a'_{14})^{(1)}G_{14}$ and by integrating $G_{14} \leq \left((\hat{M}_{13})^{(1)}\right)_2 = G_{14}^0 + 2(a_{14})^{(1)}\left((\hat{M}_{13})^{(1)}\right)_1/(a'_{14})^{(1)}$ In the same way , one can obtain $G_{15} \leq \left((\hat{M}_{13})^{(1)}\right)_3 = G_{15}^0 + 2(a_{15})^{(1)}\left((\hat{M}_{13})^{(1)}\right)_2/(a'_{15})^{(1)}$ If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.	187
Remark 4: If G_{13} *is* bounded, from below, the same property holds for G_{14} *and* G_{15} . The proof is analogous with the preceding one. An analogous property is true if G_{14} is bounded from below.	188
Remark 5: If T_{13} is bounded from below and $\lim_{t\to\infty}((b''_i)^{(1)}(G(t),t)) = (b'_{14})^{(1)}$ then $T_{14} \to \infty$. **Definition of** $(m)^{(1)}$ and ε_1 : Indeed let t_1 be so that for $t > t_1$ $(b_{14})^{(1)} - (b''_i)^{(1)}(G(t),t) < \varepsilon_1, T_{13}(t) > (m)^{(1)}$	189
Then $\frac{dT_{14}}{dt} \geq (a_{14})^{(1)}(m)^{(1)} - \varepsilon_1 T_{14}$ which leads to $T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{\varepsilon_1}\right)(1 - e^{-\varepsilon_1 t}) + T_{14}^0 e^{-\varepsilon_1 t}$ If we take t such that $e^{-\varepsilon_1 t} = \frac{1}{2}$ it results	

$T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{2}\right), \quad t = log\frac{2}{\varepsilon_1}$ By taking now ε_1 sufficiently small one sees that T_{14} is unbounded. The same property holds for T_{15} if $\lim_{t\to\infty}(b''_{15})^{(1)}(G(t),t) = (b'_{15})^{(1)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	
It is now sufficient to take $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$ and to choose $(\hat{P}_{16})^{(2)}$ *and* $(\hat{Q}_{16})^{(2)}$ large to have	190
$\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[(\hat{P}_{16})^{(2)} + ((\hat{P}_{16})^{(2)} + G_j^0)e^{-\left(\frac{(\hat{P}_{16})^{(2)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{16})^{(2)}$	191
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$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{Q}_{44})^{(9)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(\left((G_{47})^{(1)},(T_{47})^{(1)}\right),\left((G_{47})^{(2)},(T_{47})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t) - G_i^{(2)}(t)\right\|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t) - T_i^{(2)}(t)\right\|e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})} : \left(\widetilde{(G_{47})},\widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}),(T_{47})\right)$ It results	

$$\left|\tilde{G}_{44}^{(1)}-\tilde{G}_{i}^{(2)}\right| \leq \int_0^t (a_{44})^{(9)} \left|G_{45}^{(1)}-G_{45}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}}\, ds_{(44)} +$$
$$\int_0^t \{(a_{44}^{'})^{(9)} \left|G_{44}^{(1)}-G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$$
$$(a_{44}^{''})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)}-G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$$
$$G_{44}^{(2)}\left|(a_{44}^{''})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)-(a_{44}^{''})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}}\} ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)}-G^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)}+(a_{44}^{'})^{(9)}+(\widehat{A}_{44})^{(9)}+(\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right) d\left(\left((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}^{''})^{(9)}$ and $(b_{44}^{''})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(9)} t\right)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$ **:**

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t),t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t),t) = (b_{46}')^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14},t) + (a_{14}'')^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b_{13}')^{(1)} + (b_{14}')^{(1)} - (b_{13}'')^{(1)}(G,t) - (b_{14}'')^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if \ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$	283

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)} + (r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)} + (r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)} - (b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)} + (r_{13})^{(1)} + (R_2)^{(1)})}\left[e^{((R_1)^{(1)} + (r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\big((G_{19}), t\big) - (b_{17}^{''})^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\big(u^{(2)}\big)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},$ ***if*** $(\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)},$ ***if*** $(\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)},$ and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},$ ***if*** $(\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},$ ***if*** $(u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)},$ ***if*** $(u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)},$ and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},$ ***if*** $(\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0$, $(\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0$, $(u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
Definition of $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},\ \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},\ \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\left((G_{27}), t\right) - (b''_{25})^{(4)}\left((G_{27}), t\right) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)}, \ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}, \boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)}, \ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)}, \ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}, \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>Definition of</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>Behavior of the solutions of equation</u> <u>Theorem 2:</u> If we denote and define <u>Definition of</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>Definition of</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},$ ***if*** $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},$ ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)},$ ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \le G_{28}(t) \le G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \le G_{29}(t) \le \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \le G_{30}(t) \le\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b_{30}')^{(5)}t}\right]+T_{30}^0 e^{-(b_{30}')^{(5)}t} \le T_{30}(t) \le$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)}=(a_{28})^{(5)}(m_2)^{(5)}-(a_{28}')^{(5)}$ $(S_2)^{(5)}=(a_{30})^{(5)}-(p_{30})^{(5)}$ $(R_1)^{(5)}=(b_{28})^{(5)}(\mu_2)^{(5)}-(b_{28}')^{(5)}$ $(R_2)^{(5)}=(b_{30}')^{(5)}-(r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \le -(a_{32}')^{(6)}+(a_{33}')^{(6)}-(a_{32}'')^{(6)}(T_{33},t)+(a_{33}'')^{(6)}(T_{33},t) \le -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \le -(b_{32}')^{(6)}+(b_{33}')^{(6)}-(b_{32}'')^{(6)}((G_{35}),t)-(b_{33}'')^{(6)}((G_{35}),t) \le -(\tau_1)^{(6)}$	349
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)}>0, (\nu_2)^{(6)}<0$ and respectively $(u_1)^{(6)}>0, (u_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_1)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0, (\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0, (\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)}, (m_1)^{(6)}=(\nu_1)^{(6)}, \; \boldsymbol{if} \; (\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)}, (m_1)^{(6)}=(\bar{\nu}_6)^{(6)}, \boldsymbol{if} \; (\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)}, (m_1)^{(6)}=(\nu_0)^{(6)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a'_{38})^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a'_{38})^{(7)}t}] + G_{38}^0 e^{-(a'_{38})^{(7)}t}\right)$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b'_{38})^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b'_{38})^{(7)}t}\right] + T_{38}^0 e^{-(b'_{38})^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
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and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_1)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ and	
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$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, ***if*** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, ***if*** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, ***if*** $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, ***if*** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, ***if*** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)} - (p_{44})^{(9)} - (S_2)^{(9)})} \left[e^{((S_1)^{(9)} - (p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq \frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)} - (a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)} + (r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)} + (r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)} - (b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)} + (r_{44})^{(9)} + (R_2)^{(9)})} \left[e^{((R_1)^{(9)} + (r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)} (m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)} (\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}^{'})^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right) - (a_{14}^{''})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)}=\frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0<(\nu_1)^{(2)}<(\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}<(\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0<(\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t)=\frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)}=(a''_{17})^{(2)}, then\ (\sigma_1)^{(2)}=(\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)}=(\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)}=(\nu_1)^{(2)}$ then $\nu^{(2)}(t)=(\nu_0)^{(2)}$ and as a consequence $G_{16}(t)=(\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)}=(b''_{17})^{(2)}, then\ (\tau_1)^{(2)}=(\tau_2)^{(2)}$ and then $(u_1)^{(2)}=(\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)}=(u_1)^{(2)}$ then $T_{16}(t)=(u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}^{'})^{(3)} - (a_{21}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right) - (a_{21}^{''})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{24}'')^{(4)} = (a_{25}'')^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b_{24}'')^{(4)} = (b_{25}'')^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}')^{(5)} - (a_{29}')^{(5)} + (a_{28}'')^{(5)}(T_{29}, t)\right) - (a_{29}'')^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}$, $\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}$, $\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$

$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)}$, $\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)}$, $\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ **Definition of** $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain	415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}, \quad \boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}, \quad \boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\quad \boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)}=\frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0<(\nu_1)^{(7)}<(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}<(\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0<(\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t)=\frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t)=\frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)}=(a''_{37})^{(7)}, then\ (\sigma_1)^{(7)}=(\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)}=(\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)}=(\nu_1)^{(7)}$ then $\nu^{(7)}(t)=(\nu_0)^{(7)}$ and as a consequence $G_{36}(t)=(\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)}=(b''_{37})^{(7)}, then\ (\tau_1)^{(7)}=(\tau_2)^{(7)}$ and then $(u_1)^{(7)}=(\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)}=(u_1)^{(7)}$ then $T_{36}(t)=(u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}^{'})^{(8)} - (a_{41}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right) - (a_{41}^{''})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .** Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$**.**	
Proof : From 99,20,44,22,23,44 we obtain $$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}$, $\boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get	

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$**, and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ \ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\,]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (p) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	
Definition and uniqueness of T_{37}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$	500
Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right]+(b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right]+(b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18})$, G_{16}, G_{18} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22})$, G_{20}, G_{22} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27}) + (b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right] + (b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26})$, G_{24}, G_{26} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31}) + (b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right] + (b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30})$, G_{28}, G_{30} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35}) + (b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right] + (b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34})$, G_{32}, G_{34} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39}) + (b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right] + (b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38})$, G_{36}, G_{38} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}(\,(G_{19})^*\,) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}(\,(G_{23})^*\,) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ and $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ and $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}((G_{31})^{*}) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^{*}) = (q_{33})^{(6)} \quad , \frac{\partial (b_i'')^{(6)}}{\partial G_j}\left(\left(G_{35}\right)^{*}\right) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt}=-\left((a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)\mathbb{G}_{42}+(a_{42})^{(8)}\mathbb{G}_{41}-(q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt}=-\left((b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)\mathbb{T}_{40}+(b_{40})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt}=-\left((b_{41}^{'})^{(8)}-(r_{41})^{(8)}\right)\mathbb{T}_{41}+(b_{41})^{(8)}\mathbb{T}_{40}+\sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt}=-\left((b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\mathbb{T}_{42}+(b_{42})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** **Denote**	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad , T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*})=(q_{45})^{(9)} \quad , \frac{\partial(b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right)=s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt}=-\left((a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\mathbb{G}_{44}+(a_{44})^{(9)}\mathbb{G}_{45}-(q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt}=-\left((a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)\mathbb{G}_{45}+(a_{45})^{(9)}\mathbb{G}_{44}-(q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt}=-\left((a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)\mathbb{G}_{46}+(a_{46})^{(9)}\mathbb{G}_{45}-(q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt}=-\left((b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)\mathbb{T}_{44}+(b_{44})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt}=-\left((b_{45}^{'})^{(9)}-(r_{45})^{(9)}\right)\mathbb{T}_{45}+(b_{45})^{(9)}\mathbb{T}_{44}+\sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt}=-\left((b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\mathbb{T}_{46}+(b_{46})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)}+(b_{15}^{'})^{(1)}-(r_{15})^{(1)}\right)\{\left((\lambda)^{(1)}+(a_{15}^{'})^{(1)}+(p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$+\Big(\big((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\big)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\Big)$

$\Big(\big((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\big)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\Big)$

$\Big(\big((\lambda)^{(1)}\big)^{2}+\big((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\big)(\lambda)^{(1)}\Big)$

$\Big(\big((\lambda)^{(1)}\big)^{2}+\big((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\big)(\lambda)^{(1)}\Big)$

$+\Big(\big((\lambda)^{(1)}\big)^{2}+\big((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\big)(\lambda)^{(1)}\Big)(q_{15})^{(1)}G_{15}$

$+\big((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\big)\big((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\big)$

$\Big(\big((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\big)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\Big)\}=0$

$+$

$\big((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\big)\{\big((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\big)$

$\Big[\Big(\big((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\big)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\Big)\Big]$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\Big)$

$+\Big(\big((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\big)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\Big)$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\Big)$

$\Big(\big((\lambda)^{(2)}\big)^{2}+\big((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\big)(\lambda)^{(2)}\Big)$

$\Big(\big((\lambda)^{(2)}\big)^{2}+\big((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\big)(\lambda)^{(2)}\Big)$

$+\Big(\big((\lambda)^{(2)}\big)^{2}+\big((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\big)(\lambda)^{(2)}\Big)(q_{18})^{(2)}G_{18}$

$+\big((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\big)\big((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\big)$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\Big)\}=0$

$+$

$\big((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\big)\{\big((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\big)$

$\Big[\Big(\big((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\big)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\Big)\Big]$

$\Big(\big((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\big)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\Big)$

$$+\Big(\big((\lambda)^{(3)}+(a'_{21})^{(3)}+(p_{21})^{(3)}\big)(q_{20})^{(3)}G^*_{20}+(a_{20})^{(3)}(q_{21})^{(1)}G^*_{21}\Big)$$

$$\Big(\big((\lambda)^{(3)}+(b'_{20})^{(3)}-(r_{20})^{(3)}\big)s_{(21),(20)}T^*_{21}+(b_{21})^{(3)}s_{(20),(20)}T^*_{20}\Big)$$

$$\Big(\big((\lambda)^{(3)}\big)^2+\big((a'_{20})^{(3)}+(a'_{21})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\big)(\lambda)^{(3)}\Big)$$

$$\Big(\big((\lambda)^{(3)}\big)^2+\big((b'_{20})^{(3)}+(b'_{21})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\big)(\lambda)^{(3)}\Big)$$

$$+\Big(\big((\lambda)^{(3)}\big)^2+\big((a'_{20})^{(3)}+(a'_{21})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\big)(\lambda)^{(3)}\Big)(q_{22})^{(3)}G_{22}$$

$$+\big((\lambda)^{(3)}+(a'_{20})^{(3)}+(p_{20})^{(3)}\big)\big((a_{22})^{(3)}(q_{21})^{(3)}G^*_{21}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G^*_{20}\big)$$

$$\Big(\big((\lambda)^{(3)}+(b'_{20})^{(3)}-(r_{20})^{(3)}\big)s_{(21),(22)}T^*_{21}+(b_{21})^{(3)}s_{(20),(22)}T^*_{20}\Big)\}=0$$

+

$$\big((\lambda)^{(4)}+(b'_{26})^{(4)}-(r_{26})^{(4)}\big)\{\big((\lambda)^{(4)}+(a'_{26})^{(4)}+(p_{26})^{(4)}\big)$$

$$\Big[\Big(\big((\lambda)^{(4)}+(a'_{24})^{(4)}+(p_{24})^{(4)}\big)(q_{25})^{(4)}G^*_{25}+(a_{25})^{(4)}(q_{24})^{(4)}G^*_{24}\Big)\Big]$$

$$\Big(\big((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\big)s_{(25),(25)}T^*_{25}+(b_{25})^{(4)}s_{(24),(25)}T^*_{25}\Big)$$

$$+\Big(\big((\lambda)^{(4)}+(a'_{25})^{(4)}+(p_{25})^{(4)}\big)(q_{24})^{(4)}G^*_{24}+(a_{24})^{(4)}(q_{25})^{(4)}G^*_{25}\Big)$$

$$\Big(\big((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\big)s_{(25),(24)}T^*_{25}+(b_{25})^{(4)}s_{(24),(24)}T^*_{24}\Big)$$

$$\Big(\big((\lambda)^{(4)}\big)^2+\big((a'_{24})^{(4)}+(a'_{25})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\big)(\lambda)^{(4)}\Big)$$

$$\Big(\big((\lambda)^{(4)}\big)^2+\big((b'_{24})^{(4)}+(b'_{25})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\big)(\lambda)^{(4)}\Big)$$

$$+\Big(\big((\lambda)^{(4)}\big)^2+\big((a'_{24})^{(4)}+(a'_{25})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\big)(\lambda)^{(4)}\Big)(q_{26})^{(4)}G_{26}$$

$$+\big((\lambda)^{(4)}+(a'_{24})^{(4)}+(p_{24})^{(4)}\big)\big((a_{26})^{(4)}(q_{25})^{(4)}G^*_{25}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G^*_{24}\big)$$

$$\Big(\big((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\big)s_{(25),(26)}T^*_{25}+(b_{25})^{(4)}s_{(24),(26)}T^*_{24}\Big)\}=0$$

+

$$\big((\lambda)^{(5)}+(b'_{30})^{(5)}-(r_{30})^{(5)}\big)\{\big((\lambda)^{(5)}+(a'_{30})^{(5)}+(p_{30})^{(5)}\big)$$

$$\Big[\Big(\big((\lambda)^{(5)}+(a'_{28})^{(5)}+(p_{28})^{(5)}\big)(q_{29})^{(5)}G^*_{29}+(a_{29})^{(5)}(q_{28})^{(5)}G^*_{28}\Big)\Big]$$

$$\Big(\big((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)}\big)s_{(29),(29)}T^*_{29}+(b_{29})^{(5)}s_{(28),(29)}T^*_{29}\Big)$$

$$+\Big(\big((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)}\big)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\Big)$$

$$\Big(\big((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\big)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\Big)$$

$$\Big(\big((\lambda)^{(5)}\big)^{2}+\big((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\big)(\lambda)^{(5)}\Big)$$

$$\Big(\big((\lambda)^{(5)}\big)^{2}+\big((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\big)(\lambda)^{(5)}\Big)$$

$$+\Big(\big((\lambda)^{(5)}\big)^{2}+\big((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\big)(\lambda)^{(5)}\Big)(q_{30})^{(5)}G_{30}$$

$$+\big((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\big)\big((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\big)$$

$$\Big(\big((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\big)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\Big)\}=0$$

+

$$\big((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)}\big)\{\big((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)}\big)$$

$$\Big[\Big(\big((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\big)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\Big)\Big]$$

$$\Big(\big((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\big)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\Big)$$

$$+\Big(\big((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)}\big)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\Big)$$

$$\Big(\big((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\big)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\Big)$$

$$\Big(\big((\lambda)^{(6)}\big)^{2}+\big((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\big)(\lambda)^{(6)}\Big)$$

$$\Big(\big((\lambda)^{(6)}\big)^{2}+\big((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\big)(\lambda)^{(6)}\Big)$$

$$+\Big(\big((\lambda)^{(6)}\big)^{2}+\big((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\big)(\lambda)^{(6)}\Big)(q_{34})^{(6)}G_{34}$$

$$+\big((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\big)\big((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\big)$$

$$\Big(\big((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\big)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\Big)\}=0$$

+

$$\big((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)}\big)\{\big((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)}\big)$$

$$\Big[\Big(\big((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\big)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\Big)\Big]$$

$$\Big(\big((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\big)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\Big)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}')^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}')^{(7)}+(b_{37}')^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b_{42}')^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}')^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}')^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}')^{(8)}+(b_{41}')^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b_{46}')^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}')^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)}+(a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceleralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION SEVENTEEN

Newton-Cartan Structure With An Additional Gauge Field Which Couples To Mass

INTRODUCTION—VARIABLES USED

Curved non-relativistic spacetimes, Newtonian gravitation and massive matter Michael Geracie, Kartik Prabhu, Matthew M. Roberts

(1) In this paper authors construct such a Bargmann spacetime in (eb) complete generality without (e) any prior restrictions on (eb) the fields specifying the geometry.
(2) The resulting spacetime structure includes (e) the familiar Newton-Cartan structure with (e&eb) an additional gauge field which couples to (e&eb) mass.
(3) Authors illustrate the matter coupling with a few examples. The general spacetime constructed also

includes (e) as a special case the covariant description of (e) Newtonian gravity, which has been thoroughly investigated in previous works.

(4) They also show how our Bargmann spacetimes arise from (e) a suitable non-relativistic limit of (e) Lorentzian spacetimes.

(5) In a companion paper [arXiv: 1503.02680] authors use this Bargmann spacetime structure to (e) investigate the details of matter couplings, including (e) the Noether-Ward identities, and transport phenomena and (e&eb) thermodynamics of non-relativistic fluids.

(6) Comments: v5: update references matches version published in JMP v4: minor text changes. Version accepted in Journal of Mathematical Physics v3: improved discussion of NR limit and added refs, v2: updated references and text. v1: 39 pages, 2 figures Subjects: High Energy Physics - Theory (hep-th); General Relativity and Quantum Cosmology (gr-qc); Mathematical Physics (math-ph) Journal reference: J. Math. Phys. 56, 103505 (2015) DOI: 10.1063/1.4932967 Report number: EFI-15-14 Cite as: arXiv: 1503.02682 [hep-th] (or arXiv: 1503.02682v5 [hep-th] for this version)

NOTATION

Module One

In this paper authors construct such a Bargmann spacetime in (eb) complete generality without (e) any prior restrictions on (eb) the fields specifying the geometry

G_{13} : Category one of **Bargmann spacetime;** complete generality without (e) any prior restrictions on (eb) the fields specifying the geometry

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of complete generality without (e) any prior restrictions on (eb) the fields specifying the geometry; **Bargmann spacetime**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

In this paper authors construct such a Bargmann spacetime in complete generality without (e) any prior restrictions on (eb) the fields specifying the geometry

G_{16} : Category one of any prior restrictions on (eb) the fields specifying the geometry

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of Bargmann spacetime in complete generality

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

In this paper authors construct such a Bargmann spacetime in complete generality without any prior

restrictions on (eb) the fields specifying the geometry	
G_{20} : Category one of **Bargmann spacetime in complete generality without any prior restrictions;** fields specifying the geometry G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of fields specifying the geometry **;Bargmann spacetime in complete generality without any prior restrictions** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Authors illustrate the matter coupling with a few examples. The general spacetime constructed also includes (e) as a special case the covariant description of (e) Newtonian gravity, which has been thoroughly investigated in previous works	
G_{24} : Category one of general spacetime constructed; **covariant description of (e) Newtonian gravity, which has been thoroughly investigated in previous works** G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of **covariant description of (e) Newtonian gravity, which has been thoroughly investigated in previous works** ;general spacetime constructed T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five The general spacetime constructed also includes as a special case the covariant description of (e) Newtonian gravity, which has been thoroughly investigated in previous works	
G_{28} : Category one of Newtonian gravity, which has been thoroughly investigated in previous works G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of general spacetime constructed also includes as a special case the covariant description T_{29} : Category two of SAS T_{30} : Category three of SAS	

Module six They also show how our Bargmann spacetimes arise from (e) a suitable non-relativistic limit of (e) Lorentzian spacetimes	
G_{32} : Category one of suitable non-relativistic limit of (e) Lorentzian spacetimes G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of Bargmann spacetimes T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven They also show how our Bargmann spacetimes arise from a suitable non-relativistic limit of (e) Lorentzian spacetimes	
G_{36} : Category one of Lorentzian spacetimes G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of Bargmann spacetimes arise from a suitable non-relativistic limit T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight In a companion paper [arXiv: 1503.02680] authors use this Bargmann spacetime structure to (e) investigate the details of matter couplings, including (e) the Noether-Ward identities, and transport phenomena and (e&eb) thermodynamics of non-relativistic fluids.	
G_{40} : Category one of Bargmann spacetime structure G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of details of matter couplings, including (e) the Noether-Ward identities, and transport phenomena and (e&eb) thermodynamics of non-relativistic fluids T_{41} : Category two of SAS T_{42} : Category three of SAS	

Module Nine In a companion paper [arXiv: 1503.02680] authors use this Bargmann spacetime structure to investigate the details of matter couplings, including the Noether-Ward identities, and transport phenomena and (e&eb) thermodynamics of non-relativistic fluids.	
G_{44} : Category one of Bargmann spacetime structure to investigate the details of matter couplings, G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of transport phenomena and (e&eb) thermodynamics of non-relativistic fluids. T_{45} : Category two of SAS T_{46} : Category three of SAS	

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t)\right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t)\right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t)\right] T_{13}$	4

$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	

Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)} (T_{29}, t) \right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)} (T_{29}, t) \right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)} (T_{29}, t) \right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)} \left((G_{31}), t \right) \right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)} \left((G_{31}), t \right) \right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)} \left((G_{31}), t \right) \right] T_{30}$	30
$+(a''_{28})^{(5)} (T_{29}, t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)} \left((G_{31}), t \right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)} (T_{33}, t) \right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)} (T_{33}, t) \right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)} (T_{33}, t) \right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)} \left((G_{35}), t \right) \right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)} \left((G_{35}), t \right) \right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)} \left((G_{35}), t \right) \right] T_{34}$	36
$+(a''_{32})^{(6)} (T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)} (T_{37}, t) \right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}, t) \right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}, t) \right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)} \left((G_{39}), t \right) \right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)} \left((G_{39}), t \right) \right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)} \left((G_{39}), t \right) \right] T_{38}$	*42*
$+(a''_{36})^{(7)} (T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)} (T_{41}, t) \right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}, t) \right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}, t) \right] G_{42}$	*45*

$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} \left((G_{43}), t \right) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} \left((G_{43}), t \right) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} \left((G_{43}), t \right) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)} (T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)} (T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{46}$	54
$+(a_{44}^{''})^{(9)} (T_{45}, t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)} \left((G_{47}), t \right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)} (T_{14}, t)} \boxed{+(a_{16}^{''})^{(2,2,)} (T_{17}, t)} \boxed{+(a_{20}^{''})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a_{36}^{''})^{(7,7)} (T_{37}, t)} \boxed{+(a_{40}^{''})^{(8,8)} (T_{41}, t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{matrix} \right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a_{14}^{'})^{(1)} \boxed{+(a_{14}^{''})^{(1)} (T_{14}, t)} \boxed{+(a_{17}^{''})^{(2,2,)} (T_{17}, t)} \boxed{+(a_{21}^{''})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a_{37}^{''})^{(7,7)} (T_{37}, t)} \boxed{+(a_{41}^{''})^{(8,8)} (T_{41}, t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{matrix} \right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a_{15}^{'})^{(1)} \boxed{+(a_{15}^{''})^{(1)} (T_{14}, t)} \boxed{+(a_{18}^{''})^{(2,2,)} (T_{17}, t)} \boxed{+(a_{22}^{''})^{(3,3,)} (T_{21}, t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)} (T_{25}, t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,)} (T_{29}, t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,)} (T_{33}, t)} \\ \boxed{+(a_{38}^{''})^{(7,7)} (T_{37}, t)} \boxed{+(a_{42}^{''})^{(8,8)} (T_{41}, t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)} (T_{45}, t)} \end{matrix} \right] G_{15}$	57
Where $\boxed{(a_{13}^{''})^{(1)} (T_{14}, t)}$, $\boxed{(a_{14}^{''})^{(1)} (T_{14}, t)}$, $\boxed{(a_{15}^{''})^{(1)} (T_{14}, t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,)} (T_{17}, t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)} (T_{17}, t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)} (T_{17}, t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,)} (T_{21}, t)}$, $\boxed{+(a_{21}^{''})^{(3,3,)} (T_{21}, t)}$, $\boxed{+(a_{22}^{''})^{(3,3,)} (T_{21}, t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}^{''})^{(4,4,4,4,)} (T_{25}, t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,)} (T_{25}, t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,)} (T_{25}, t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}^{''})^{(5,5,5,5,)} (T_{29}, t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,)} (T_{29}, t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,)} (T_{29}, t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}^{''})^{(6,6,6,6,)} (T_{33}, t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,)} (T_{33}, t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,)} (T_{33}, t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}^{''})^{(7,7)} (T_{37}, t)}$ $\boxed{+(a_{37}^{''})^{(7,7)} (T_{37}, t)}$ $\boxed{+(a_{36}^{''})^{(7,7)} (T_{37}, t)}$ are seventh augmentation coefficient for 1,2,3	

$\boxed{+(a_{40}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}'')^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b_{13}')^{(1)}\boxed{-(b_{13}'')^{(1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b_{14}')^{(1)}\boxed{-(b_{14}'')^{(1)}(G,t)} \boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b_{15}')^{(1)}\boxed{-(b_{15}'')^{(1)}(G,t)} \boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$	*60*
Where $\boxed{-(b_{13}'')^{(1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{40}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{41}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{42}'')^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a_{16}')^{(2)}\boxed{+(a_{16}'')^{(2)}(T_{17},t)} \boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16}$	*61*

$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a_{17}^{'})^{(2)} \boxed{+(a_{17}^{''})^{(2)}(T_{17},t)} \boxed{+(a_{14}^{''})^{(1,1,)}(T_{14},t)} \boxed{+(a_{21}^{''})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7,7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a_{18}^{'})^{(2)} \boxed{+(a_{18}^{''})^{(2)}(T_{17},t)} \boxed{+(a_{15}^{''})^{(1,1,)}(T_{14},t)} \boxed{+(a_{22}^{''})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7,7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	63
Where $\boxed{+(a_{16}^{''})^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{13}^{''})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}^{''})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}^{''})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}^{''})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{36}^{''})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}^{''})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}^{''})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{40}^{''})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{44}^{''})^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b_{16}^{'})^{(2)} \boxed{-(b_{16}^{''})^{(2)}(G_{19},t)} \boxed{-(b_{13}^{''})^{(1,1,)}(G,t)} \boxed{-(b_{20}^{''})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}^{''})^{(7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8)}(G_{43},t)} \boxed{-(b_{44}^{''})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b_{17}^{'})^{(2)} \boxed{-(b_{17}^{''})^{(2)}(G_{19},t)} \boxed{-(b_{14}^{''})^{(1,1,)}(G,t)} \boxed{-(b_{21}^{''})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}^{''})^{(7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8)}(G_{43},t)} \boxed{-(b_{45}^{''})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b_{18}^{'})^{(2)} \boxed{-(b_{18}^{''})^{(2)}(G_{19},t)} \boxed{-(b_{15}^{''})^{(1,1,)}(G,t)} \boxed{-(b_{22}^{''})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{38}^{''})^{(7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8)}(G_{43},t)} \boxed{-(b_{46}^{''})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18}$	66
where $\boxed{-(b_{16}^{''})^{(2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{13}^{''})^{(1,1,)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1,1,)}(G,t)}$ are second detrition coefficients for category	

1,2 and 3

$-(b_{20}'')^{(3,3,3,)}(G_{23},t)$, $-(b_{21}'')^{(3,3,3,)}(G_{23},t)$, $-(b_{22}'')^{(3,3,3,)}(G_{23},t)$ are third detrition coefficients for category 1,2 and 3

$-(b_{24}'')^{(4,4,4,4,4)}(G_{27},t)$, $-(b_{25}'')^{(4,4,4,4,4)}(G_{27},t)$, $-(b_{26}'')^{(4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1,2 and 3

$-(b_{28}'')^{(5,5,5,5,5)}(G_{31},t)$, $-(b_{29}'')^{(5,5,5,5,5)}(G_{31},t)$, $-(b_{30}'')^{(5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1,2 and 3

$-(b_{32}'')^{(6,6,6,6,6)}(G_{35},t)$, $-(b_{33}'')^{(6,6,6,6,6)}(G_{35},t)$, $-(b_{34}'')^{(6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1,2 and 3

$-(b_{36}'')^{(7,7,7)}(G_{39},t)$, $-(b_{37}'')^{(7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3

$-(b_{40}'')^{(8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8)}(G_{43},t)$, $-(b_{42}'')^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3

$-(b_{44}'')^{(9,9)}(G_{47},t)$, $-(b_{46}'')^{(9,9)}(G_{47},t)$, $-(b_{45}'')^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t) + (a_{16}'')^{(2,2,2)}(T_{17},t) + (a_{13}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{36}'')^{(7,7,7,7)}(T_{37},t) + (a_{40}'')^{(8,8,8,8)}(T_{41},t) + (a_{44}'')^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{20} \quad 67$$

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21},t) + (a_{17}'')^{(2,2,2)}(T_{17},t) + (a_{14}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{37}'')^{(7,7,7,7)}(T_{37},t) + (a_{41}'')^{(8,8,8,8)}(T_{41},t) + (a_{45}'')^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{21} \quad 68$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21},t) + (a_{18}'')^{(2,2,2)}(T_{17},t) + (a_{15}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{38}'')^{(7,7,7,7)}(T_{37},t) + (a_{42}'')^{(8,8,8,8)}(T_{41},t) + (a_{46}'')^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{22} \quad 69$$

$+(a_{20}'')^{(3)}(T_{21},t)$, $+(a_{21}'')^{(3)}(T_{21},t)$, $+(a_{22}'')^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3

$+(a_{16}'')^{(2,2,2)}(T_{17},t)$, $+(a_{17}'')^{(2,2,2)}(T_{17},t)$, $+(a_{18}'')^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3

$+(a_{13}'')^{(1,1,1,)}(T_{14},t)$, $+(a_{14}'')^{(1,1,1,)}(T_{14},t)$, $+(a_{15}'')^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3

$+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3

$+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3

$+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3

$+(a_{36}'')^{(7,7,7,7)}(T_{37},t)$, $+(a_{37}'')^{(7,7,7,7)}(T_{37},t)$, $+(a_{38}'')^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation

coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)}\boxed{-(b''_{20})^{(3)}(G_{23},t)}\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)}\boxed{-(b''_{21})^{(3)}(G_{23},t)}\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)}\boxed{-(b''_{22})^{(3)}(G_{23},t)}\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[\begin{matrix} (a'_{24})^{(4)}\boxed{+(a''_{24})^{(4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25}$$ 74

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$$ 75

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24}$$ 76

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25}$$ 77

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$$ 78

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients*

$for\ category$ 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category$ 1, 2 and 3

$\boxed{-(b_{13}'')^{(1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,1,1)}(G,t)}$

$are\ fourth\ detrition\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2)}(G_{19},t)}$

$are\ fifth\ detrition\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3)}(G_{23},t)}$

$are\ sixth\ detrition\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{-(b_{36}'')^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7)}(G_{39},t)}$

$are\ seventh\ detrition\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{-(b_{40}'')^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8,8)}(G_{43},t)}$

$are\ eighth\ detrition\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{-(b_{46}'')^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a_{28}')^{(5)} \boxed{+(a_{28}'')^{(5)}(T_{29},t)} \boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28} \quad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a_{29}')^{(5)} \boxed{+(a_{29}'')^{(5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29} \quad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a_{30}')^{(5)} \boxed{+(a_{30}'')^{(5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30} \quad 81$$

$Where$ $\boxed{+(a_{28}'')^{(5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5)}(T_{29},t)}$ $are\ first\ augmentation$ $coefficients\ for\ category$ 1, 2 and 3

And $\boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)}$ $are\ second\ augmentation$ $coefficient\ for\ category$ 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation$ $coefficient\ for\ category$ 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation

coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[\begin{matrix}(b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\ \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{28}$$	82
$$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[\begin{matrix}(b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\ \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{29}$$	83
$$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[\begin{matrix}(b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\ \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{30}$$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[\begin{matrix}(a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\ \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\ \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\ \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\ \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\ \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\ \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{32}$$	85

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34} \quad 87$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$
seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$
Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34} \quad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)}\boxed{+(a''_{36})^{(7)}(T_{37},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$$ 91

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)}\boxed{+(a''_{37})^{(7)}(T_{37},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$$ 92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix} (a'_{38})^{(7)}\boxed{+(a''_{38})^{(7)}(T_{37},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$$ 93

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)$ are eighth augmentation coefficient for 1,2,3 $+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	
Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3 $-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)$, $-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)$	

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a_{40}')^{(8)}\boxed{+(a_{40}'')^{(8)}(T_{41},t)} & \boxed{+(a_{16}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a_{20}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a_{28}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a_{41}')^{(8)}\boxed{+(a_{41}'')^{(8)}(T_{41},t)} & \boxed{+(a_{17}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a_{21}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a_{29}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a_{42}')^{(8)}\boxed{+(a_{42}'')^{(8)}(T_{41},t)} & \boxed{+(a_{18}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a_{22}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a_{30}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$$

Where $\boxed{+(a_{40}'')^{(8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \begin{bmatrix} (a_{44}^{'})^{(9)} \boxed{+(a_{44}^{''})^{(9)}(T_{45},t)} \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13}$	96
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a_{45}^{'})^{(9)} \boxed{+(a_{45}^{''})^{(9)}(T_{45},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a_{46}^{'})^{(9)} \boxed{+(a_{46}^{''})^{(9)}(T_{37},t)} \boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$	
Where $\boxed{+(a_{44}^{''})^{(9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} =$ $(b_{44})^{(9)}T_{45} -$	

$$\left[\begin{array}{l}(b_{44}^{'})^{(9)}\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}\ \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{array}\right] T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$$(b_{45})^{(9)}T_{44} - \left[\begin{array}{l}(b_{45}^{'})^{(9)}\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}\ \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{array}\right] T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$$(b_{46})^{(9)}T_{45} - \left[\begin{array}{l}(b_{46}^{'})^{(9)}\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}\ \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{array}\right] T_{15}$$

Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3

Where we suppose

$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i, j = 13,14,15$ *97*

The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(1)}, \ (r_i)^{(1)}$:

$(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	

$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2 \to \infty} (a_i'')^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G \to \infty} (b_i'')^{(2)}\left((G_{19}),t\right) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}\left((G_{19}),t\right)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19}) - (G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i')^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$	112

The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, (r_i)^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \le (p_i)^{(3)} \le (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \le (r_i)^{(3)} \le (b_i')^{(3)} \le (\hat{B}_{20})^{(3)}$	
$lim_{T_2 \to \infty} (a_i'')^{(3)} (T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty} (b_i'')^{(3)} (G_{23}, t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}', t) - (a_i'')^{(3)}(T_{21}, t)\| \le (\hat{k}_{20})^{(3)} \|T_{21} - T_{21}'\| e^{-(\hat{M}_{20})^{(3)} t}$ $\|(b_i'')^{(3)}(G_{23}', t) - (b_i'')^{(3)}(G_{23}, t)\| < (\hat{k}_{20})^{(3)} \|\|G_{23} - G_{23}'\|\| e^{-(\hat{M}_{20})^{(3)} t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}', t)$ and $(a_i'')^{(3)}(T_{21}, t)$. (T_{21}', t) And (T_{21}, t) are points belonging to the interval $[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}} [(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}} [(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i, j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded.	117

Definition of $(p_i)^{(4)}, \ (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}),t) \leq \ (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i^{''})^{(4)}((G_{27}),t) = \ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, \ (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}',t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})',t) - (b_i^{''})^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}',t)$ and$(a_i^{''})^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} \ , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (p_i)^{(4)}, \ (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (a_i)^{(4)} + (a_i')^{(4)} + \ (\hat{A}_{24})^{(4)} + \ (\hat{P}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)} + (b_i')^{(4)} + \ (\hat{B}_{24})^{(4)} + \ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i')^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded.	122

Definition of $(p_i)^{(5)}, \ (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t) \le (p_i)^{(5)} \le (\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}\big((G_{31}),t\big) \le \ (r_i)^{(5)} \le (b_i')^{(5)} \le (\hat{B}_{28})^{(5)}$	
$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t) = \ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}$ are positive constants and $i = 28,29,30$	123
They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t) - (a_i'')^{(5)}(T_{29},t)\rvert \le (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t) - (b_i'')^{(5)}\big((G_{31}),t\big)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $\big[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}\big]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}} \ , \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and \ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)} + (a_i')^{(5)} + \ (\hat{A}_{28})^{(5)} + \ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)} + (b_i')^{(5)} + \ (\hat{B}_{28})^{(5)} + \ (\hat{Q}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$	127

The functions $(a_i^{''})^{(6)}, (b_i^{''})^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, \ (r_i)^{(6)}$: $(a_i^{''})^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i^{''})^{(6)}((G_{35}), t) \leq \ (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2 \to \infty} (a_i^{''})^{(6)} (T_{33}, t) = (p_i)^{(6)}$ $\lim_{G \to \infty} (b_i^{''})^{(6)} \left((G_{35}), t\right) = \ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(6)}(T_{33}^{'}, t) - (a_i^{''})^{(6)}(T_{33}, t) \rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}^{'} \rvert e^{-(\hat{M}_{32})^{(6)} t}$ $\lvert (b_i^{''})^{(6)}((G_{35})^{'}, t) - (b_i^{''})^{(6)}\left((G_{35}), t\right) \rvert < (\hat{k}_{32})^{(6)} \lvert\lvert (G_{35}) - (G_{35})^{'} \rvert\rvert e^{-(\hat{M}_{32})^{(6)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'}, t)$ and$(a_i^{''})^{(6)}(T_{33}, t)$. $(T_{33}^{'}, t)$ and (T_{33}, t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i^{'})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i^{'})^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i^{'})^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)} \ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	

(SSSS) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (TTTT) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37}, t) \le (p_i)^{(7)} \le (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39}, t) \le \ (r_i)^{(7)} \le (b_i^{'})^{(7)} \le (\hat{B}_{36})^{(7)}$	131
(UUUU) $\lim_{T_2 \to \infty} \ (a_i^{''})^{(7)} \, (T_{37}, t) = (p_i)^{(7)}$ *(VVVV)* $\lim_{G \to \infty} (b_i^{''})^{(7)} \left((G_{39}), t\right) = \ (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\|(a_i^{''})^{(7)}(T_{37}^{'}, t) - (a_i^{''})^{(7)}(T_{37}, t)\| \le (\hat{k}_{36})^{(7)}\|T_{37} - T_{37}^{'}\|e^{-(\hat{M}_{36})^{(7)}t}$ $\|(b_i^{''})^{(7)}((G_{39})^{'}, t) - (b_i^{''})^{(7)}\left((G_{39}), t\right)\| < (\hat{k}_{36})^{(7)}\|\|(G_{39}) - (G_{39})^{'}\|\|e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'}, t)$ and $(a_i^{''})^{(7)}(T_{37}, t)$. $(T_{37}^{'}, t)$ and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (WWWW) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (XXXX) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and \ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[\ (a_i)^{(7)} + (a_i^{'})^{(7)} + \ (\hat{A}_{36})^{(7)} + \ (\hat{P}_{36})^{(7)} \ (\hat{k}_{36})^{(7)}] < 1$	135

$\frac{1}{(\hat{M}_{36})^{(7)}}[\ (b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}] < 1$	
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41},t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}),t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i'')^{(8)}(T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i'')^{(8)}\left((G_{43}),t\right) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t) - (a_i'')^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}\left((G_{43}),t\right)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$	

Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i^{'})^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i^{'})^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i^{'})^{(9)},(a_i^{''})^{(9)},(b_i)^{(9)},(b_i^{'})^{(9)},(b_i^{''})^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i^{''})^{(9)},(b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t)\le(p_i)^{(9)}\le(\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t)\le(r_i)^{(9)}\le(b_i^{'})^{(9)}\le(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i^{''})^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i^{''})^{(9)}(G_{47},t)=(r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(9)}(T_{45}^{'},t)-(a_i^{''})^{(9)}(T_{45},t)\rvert\le(\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}^{'}\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i^{''})^{(9)}((G_{47})^{'},t)-(b_i^{''})^{(9)}((G_{47}),t)\rvert<(\hat{k}_{44})^{(9)}\lvert\lvert(G_{47})-(G_{47})^{'}\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with	

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities $\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions	152

Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	

$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}\left(T_{14}\left(s_{(13)}\right), s_{(13)}\right)\right) G_{15}\left(s_{(13)}\right)\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}\left(s_{(13)}\right) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}\left(G\left(s_{(13)}\right), s_{(13)}\right)\right) T_{13}\left(s_{(13)}\right)\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}\left(s_{(13)}\right) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}\left(G\left(s_{(13)}\right), s_{(13)}\right)\right) T_{14}\left(s_{(13)}\right)\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}\left(s_{(13)}\right) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}\left(G\left(s_{(13)}\right), s_{(13)}\right)\right) T_{15}\left(s_{(13)}\right)\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(16)}\right)\right) G_{16}\left(s_{(16)}\right)\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}\left(s_{(16)}\right) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(17)}\right)\right) G_{17}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(16)}\right)\right) G_{18}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{16}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}\left(s_{(16)}\right) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{17}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{18}\left(s_{(16)}\right)\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a'_{20})^{(3)} + a''_{20})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow$	

$\mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \leq (\ \hat{P}_{28}\ )^{(5)}\ , T_i^0 \leq (\ \hat{Q}_{28}\ )^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{28}\ )^{(5)} e^{(\ \hat{M}_{28}\ )^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{28}\ )^{(5)} e^{(\ \hat{M}_{28}\ )^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{28}\left(s_{(28)}\right)\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}\left(s_{(28)}\right) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{29}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{30}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{28}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}\left(s_{(28)}\right) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{29}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{30}\left(s_{(28)}\right)\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)}\ , T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}\left(s_{(32)}\right) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{32}\left(s_{(32)}\right)\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}\left(s_{(32)}\right) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{33}\left(s_{(32)}\right)\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}\left(s_{(32)}\right) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{34}\left(s_{(32)}\right)\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}\left(s_{(32)}\right) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left(G_{35}\left(s_{(32)}\right), s_{(32)}\right)\right) T_{32}\left(s_{(32)}\right)\right] ds_{(32)}$	

$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \leq (\hat{P}_{36})^{(7)},\ T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \leq (\hat{P}_{40})^{(8)},\ T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
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$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
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$0 \le G_i(t) - G_i^0 \le (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a'_{44})^{(9)} + a''_{44})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	

The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	167
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From which it follows that 174

$$(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$$

(G_i^0) is as defined in the statement of theorem 4

The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that

$$G_{28}(t) \leq G_{28}^0+\int_0^t\left[(a_{28})^{(5)}\left(G_{29}^0+(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\right)\right]ds_{(28)}=$$

$$\left(1+(a_{28})^{(5)}t\right)G_{29}^0+\frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t}-1\right)$$

From which it follows that 175

$$(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{P}_{28})^{(5)}+G_{29}^0\right)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)}+(\hat{P}_{28})^{(5)}\right]$$

(G_i^0) is as defined in the statement of theorem 5

The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 176

$$G_{32}(t) \leq G_{32}^0+\int_0^t\left[(a_{32})^{(6)}\left(G_{33}^0+(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}s_{(32)}}\right)\right]ds_{(32)}=$$

$$\left(1+(a_{32})^{(6)}t\right)G_{33}^0+\frac{(a_{32})^{(6)}(\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left(e^{(\hat{M}_{32})^{(6)}t}-1\right)$$

From which it follows that 177

$$(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$$

(G_i^0) is as defined in the statement of theorem 6

Analogous inequalities hold also for G_{25} , G_{26}, T_{24}, T_{25}, T_{26}

(q) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 178

$$G_{36}(t) \leq G_{36}^0+\int_0^t\left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right]ds_{(36)}=$$

$$\left(1+(a_{36})^{(7)}t\right)G_{37}^0+\frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$$

From which it follows that

$(G_{36}(t)-G_{36}^{0})e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^{0}\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^{0}}{G_{37}^{0}}\right)}+(\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
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From which it follows that $(G_{44}(t)-G_{44}^{0})e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^{0}\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^{0}}{G_{45}^{0}}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45} , $G_{46}, T_{44}, T_{45}, T_{46}$	
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The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left(\left(G^{(1)},T^{(1)}\right),\left(G^{(2)},T^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\widehat{M}_{13})^{(1)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\widehat{M}_{13})^{(1)}t}\}$	185
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Definition of $\left((\widehat{M}_{13})^{(1)}\right)_1, \left((\widehat{M}_{13})^{(1)}\right)_2$ *and* $\left((\widehat{M}_{13})^{(1)}\right)_3$: **Remark 3:** if G_{13} is bounded, the same property have also G_{14} *and* G_{15} . indeed if $G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \leq \left((\widehat{M}_{13})^{(1)}\right)_1 - (a'_{14})^{(1)} G_{14}$ and by integrating $G_{14} \leq \left((\widehat{M}_{13})^{(1)}\right)_2 = G_{14}^0 + 2(a_{14})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_1 / (a'_{14})^{(1)}$ In the same way , one can obtain $G_{15} \leq \left((\widehat{M}_{13})^{(1)}\right)_3 = G_{15}^0 + 2(a_{15})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_2 / (a'_{15})^{(1)}$ If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.	187
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$T_i(t) \geq T_i^0 e^{(-(b_i')^{(2)}t)} > 0 \quad \text{for } t > 0$	
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In order that the operator $\mathcal{A}^{(3)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	210
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$T_i\,(t) \geq T_i^0 e^{(-(b_i')^{(3)} t)} > 0 \quad \text{for } t > 0$	
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Then $\frac{dT_{21}}{dt} \geq (a_{21})^{(3)}(m)^{(3)} - \varepsilon_3 T_{21}$ which leads to $T_{21} \geq \left(\frac{(a_{21})^{(3)}(m)^{(3)}}{\varepsilon_3}\right)(1 - e^{-\varepsilon_3 t}) + T_{21}^0 e^{-\varepsilon_3 t}$ If we take t such that $e^{-\varepsilon_3 t} = \frac{1}{2}$ it results $T_{21} \geq \left(\frac{(a_{21})^{(3)}(m)^{(3)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_3}$ By taking now ε_3 sufficiently small one sees that T_{21} is unbounded. The same property holds for T_{22} if $\lim_{t\to\infty}(b_{22}'')^{(3)}((G_{23})(t),t) = (b_{22}')^{(3)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	220
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In order that the operator $\mathcal{A}^{(4)}$ transforms the space of sextuples of functions $G_i\ ,T_i$ satisfying Equations into itself	224
The operator $\mathcal{A}^{(4)}$ is a contraction with respect to the metric $d\left(\left((G_{27})^{(1)},(T_{27})^{(1)}\right),\left((G_{27})^{(2)},(T_{27})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{24})^{(4)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{24})^{(4)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{27})},\widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})},\widetilde{(T_{27})}\right)=\mathcal{A}^{(4)}((G_{27}),(T_{27}))$ It results $\left\|\tilde{G}_{24}^{(1)}-\tilde{G}_i^{(2)}\right\|\leq\int_0^t(a_{24})^{(4)}\left\|G_{25}^{(1)}-G_{25}^{(2)}\right\|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\,ds_{(24)}+$ $\int_0^t\{(a'_{24})^{(4)}\left\|G_{24}^{(1)}-G_{24}^{(2)}\right\|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{-(\hat{M}_{24})^{(4)}s_{(24)}}+$ $(a''_{24})^{(4)}\left(T_{25}^{(1)},s_{(24)}\right)\left\|G_{24}^{(1)}-G_{24}^{(2)}\right\|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}+$ $G_{24}^{(2)}\|(a''_{24})^{(4)}\left(T_{25}^{(1)},s_{(24)}\right)-(a''_{24})^{(4)}\left(T_{25}^{(2)},s_{(24)}\right)\|\ e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\}ds_{(24)}$ Where $s_{(24)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on Equations it follows	225
$\left\|(G_{27})^{(1)}-(G_{27})^{(2)}\right\|e^{-(\hat{M}_{24})^{(4)}t}\leq$ $\frac{1}{(\hat{M}_{24})^{(4)}}\left((a_{24})^{(4)}+(a'_{24})^{(4)}+(\hat{A}_{24})^{(4)}+(\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}\right)d\left(\left((G_{27})^{(1)},(T_{27})^{(1)};\ (G_{27})^{(2)},(T_{27})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	226
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Remark 17: There does not exist any t where $G_i\,(t)=0$ *and* $T_i\,(t)=0$ it results $G_i\,(t)\geq G_i^0e^{\left[-\int_0^t\{(a'_i)^{(4)}-(a''_i)^{(4)}(T_{25}(s_{(24)}),s_{(24)})\}ds_{(24)}\right]}\geq 0$	228

$T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(4)} t\right)} > 0 \quad \text{for } t > 0$

Definition of $\left((\widehat{M}_{24})^{(4)}\right)_1, \left((\widehat{M}_{24})^{(4)}\right)_2 \; and \; \left((\widehat{M}_{24})^{(4)}\right)_3$: 229

Remark 18: if G_{24} is bounded, the same property have also G_{25} *and* G_{26} . indeed if

$G_{24} < (\widehat{M}_{24})^{(4)}$ it follows $\frac{dG_{25}}{dt} \leq \left((\widehat{M}_{24})^{(4)}\right)_1 - (a_{25}^{'})^{(4)} G_{25}$ and by integrating

$G_{25} \leq \left((\widehat{M}_{24})^{(4)}\right)_2 = G_{25}^0 + 2(a_{25})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_1/(a_{25}^{'})^{(4)}$

In the same way , one can obtain

$G_{26} \leq \left((\widehat{M}_{24})^{(4)}\right)_3 = G_{26}^0 + 2(a_{26})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_2/(a_{26}^{'})^{(4)}$

If G_{25} *or* G_{26} is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.

Remark 19: If G_{24} *is* bounded, from below, the same property holds for G_{25} *and* G_{26} . The proof is analogous with the preceding one. An analogous property is true if G_{25} is bounded from below. 230

Remark 20: If T_{24} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(4)}((G_{27})(t),t)) = (b_{25}^{'})^{(4)}$ then $T_{25} \to \infty$. 231

Definition of $(m)^{(4)}$ and ε_4 :

Indeed let t_4 be so that for $t > t_4$

$(b_{25})^{(4)} - (b_i^{''})^{(4)}((G_{27})(t),t) < \varepsilon_4, T_{24}\,(t) > (m)^{(4)}$

Then $\frac{dT_{25}}{dt} \geq (a_{25})^{(4)}(m)^{(4)} - \varepsilon_4 T_{25}$ which leads to 232

$T_{25} \geq \left(\frac{(a_{25})^{(4)}(m)^{(4)}}{\varepsilon_4}\right)(1 - e^{-\varepsilon_4 t}) + T_{25}^0 e^{-\varepsilon_4 t}$ If we take t such that $e^{-\varepsilon_4 t} = \frac{1}{2}$ it results

$T_{25} \geq \left(\frac{(a_{25})^{(4)}(m)^{(4)}}{2}\right), \quad t = log\frac{2}{\varepsilon_4}$ By taking now ε_4 sufficiently small one sees that T_{25} is unbounded. The same property holds for T_{26} if $\lim_{t\to\infty}(b_{26}^{''})^{(4)}\left((G_{27})(t),t\right) = (b_{26}^{'})^{(4)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 42

Analogous inequalities hold also for G_{29} , G_{30}, T_{28}, T_{29}, T_{30}

It is now sufficient to take $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}$, $\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$ and to choose 233

$(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ large to have

$$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\left[(\hat{P}_{28})^{(5)} + \left((\hat{P}_{28})^{(5)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{28})^{(5)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{28})^{(5)}$$ 234

$\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{Q}_{28})^{(5)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{28})^{(5)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{28})^{(5)}\right]\leq(\hat{Q}_{28})^{(5)}$	235
In order that the operator $\mathcal{A}^{(5)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(5)}$ is a contraction with respect to the metric $d\left(\left((G_{31})^{(1)},(T_{31})^{(1)}\right),\left((G_{31})^{(2)},(T_{31})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{28})^{(5)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{28})^{(5)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{31})},\widetilde{(T_{31})}$: $\left(\widetilde{(G_{31})},\widetilde{(T_{31})}\right)=\mathcal{A}^{(5)}\left((G_{31}),(T_{31})\right)$ It results $\left\|\tilde{G}_{28}^{(1)}-\tilde{G}_i^{(2)}\right\|\leq\int_0^t(a_{28})^{(5)}\left\|G_{29}^{(1)}-G_{29}^{(2)}\right\|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}}ds_{(28)}+$ $\int_0^t\{(a'_{28})^{(5)}\left\|G_{28}^{(1)}-G_{28}^{(2)}\right\|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{-(\hat{M}_{28})^{(5)}s_{(28)}}+$ $(a''_{28})^{(5)}\left(T_{29}^{(1)},s_{(28)}\right)\left\|G_{28}^{(1)}-G_{28}^{(2)}\right\|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}}+$ $G_{28}^{(2)}\left\|(a''_{28})^{(5)}\left(T_{29}^{(1)},s_{(28)}\right)-(a''_{28})^{(5)}\left(T_{29}^{(2)},s_{(28)}\right)\right\|\ e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\}ds_{(28)}$ Where $s_{(28)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	236
$\left\|(G_{31})^{(1)}-(G_{31})^{(2)}\right\|e^{-(\hat{M}_{28})^{(5)}t}\leq$ $\frac{1}{(\hat{M}_{28})^{(5)}}\left((a_{28})^{(5)}+(a'_{28})^{(5)}+(\hat{A}_{28})^{(5)}+(\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}\right)d\left(\left((G_{31})^{(1)},(T_{31})^{(1)};\ (G_{31})^{(2)},(T_{31})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	237
Remark 21: The fact that we supposed $(a''_{28})^{(5)}$ and $(b''_{28})^{(5)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$ *and* $(\hat{Q}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(5)}$ and $(b''_i)^{(5)}, i=28,29,30$ depend only on T_{29} and respectively on (G_{31})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	238
Remark 22: There does not exist any t where $G_i\,(t)=0$ *and* $T_i\,(t)=0$	239

it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(5)} - (a_i'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\} ds_{(28)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{\left(-(b_i')^{(5)} t\right)} > 0$ for $t > 0$	
Definition of $\left((\widehat{M}_{28})^{(5)}\right)_1, \left((\widehat{M}_{28})^{(5)}\right)_2$ *and* $\left((\widehat{M}_{28})^{(5)}\right)_3$: **Remark 23:** if G_{28} is bounded, the same property have also G_{29} *and* G_{30} . indeed if $G_{28} < (\widehat{M}_{28})^{(5)}$ it follows $\frac{dG_{29}}{dt} \leq \left((\widehat{M}_{28})^{(5)}\right)_1 - (a_{29}')^{(5)} G_{29}$ and by integrating $G_{29} \leq \left((\widehat{M}_{28})^{(5)}\right)_2 = G_{29}^0 + 2(a_{29})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_1 / (a_{29}')^{(5)}$ In the same way , one can obtain $G_{30} \leq \left((\widehat{M}_{28})^{(5)}\right)_3 = G_{30}^0 + 2(a_{30})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_2 / (a_{30}')^{(5)}$ If G_{29} *or* G_{30} is bounded, the same property follows for G_{28} , G_{30} and G_{28} , G_{29} respectively.	240
Remark 24: If G_{28} *is* bounded, from below, the same property holds for G_{29} *and* G_{30} . The proof is analogous with the preceding one. An analogous property is true if G_{29} is bounded from below.	241
Remark 25: If T_{28} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(5)}((G_{31})(t), t)) = (b_{29}')^{(5)}$ then $T_{29} \to \infty$. **Definition of** $(m)^{(5)}$ and ε_5 : Indeed let t_5 be so that for $t > t_5$ $(b_{29})^{(5)} - (b_i'')^{(5)}((G_{31})(t), t) < \varepsilon_5, T_{28}\,(t) > (m)^{(5)}$	242
Then $\frac{dT_{29}}{dt} \geq (a_{29})^{(5)}(m)^{(5)} - \varepsilon_5 T_{29}$ which leads to $T_{29} \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{\varepsilon_5}\right)(1 - e^{-\varepsilon_5 t}) + T_{29}^0 e^{-\varepsilon_5 t}$ If we take t such that $e^{-\varepsilon_5 t} = \frac{1}{2}$ it results $T_{29} \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{2}\right), \quad t = log\frac{2}{\varepsilon_5}$ By taking now ε_5 sufficiently small one sees that T_{29} is unbounded. The same property holds for T_{30} if $\lim_{t\to\infty}(b_{30}'')^{(5)}\left((G_{31})(t), t\right) = (b_{30}')^{(5)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations Analogous inequalities hold also for G_{33} , $G_{34}, T_{32}, T_{33}, T_{34}$	243
It is now sufficient to take $\frac{(a_i)^{(6)}}{(\widehat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\widehat{M}_{32})^{(6)}} < 1$ and to choose $(\widehat{P}_{32})^{(6)}$ and $(\widehat{Q}_{32})^{(6)}$ large to have	244

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[(\hat{P}_{32})^{(6)}+((\hat{P}_{32})^{(6)}+G_j^0)e^{-\left(\frac{(\hat{P}_{32})^{(6)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{32})^{(6)}$	245
$\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[((\hat{Q}_{32})^{(6)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{32})^{(6)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{32})^{(6)}\right]\leq(\hat{Q}_{32})^{(6)}$	246
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<u>Remark 37</u> There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)} - (a_i'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for $t > 0$	275
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + \left((\widehat{P}_{44})^{(9)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[\left((\widehat{Q}_{44})^{(9)} + T_j^0\right)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}), (T_{47})\right)$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t\{(a'_{44})^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)|\ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0\ and\ T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)}t)} > 0 \quad \text{for t} > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also $G_{45}\ and\ G_{46}$. indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$$

If $G_{45}\ or\ G_{46}$ is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for $G_{45}\ and\ G_{46}$. The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a'_{13})^{(1)} + (a'_{14})^{(1)} - (a''_{13})^{(1)}(T_{14}, t) + (a''_{14})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G, t) - (b''_{14})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \le G_{14}(t) \le \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})} \left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t} \right] + G_{15}^0 e^{-(S_2)^{(1)}t} \le G_{15}(t) \le \right.$ $\left. \frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a'_{15})^{(1)})} [e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}] + G_{15}^0 e^{-(a'_{15})^{(1)}t} \right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \le T_{13}(t) \le T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \le T_{13}(t) \le \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b'_{15})^{(1)})} \left[e^{(R_1)^{(1)}t} - e^{-(b'_{15})^{(1)}t} \right] + T_{15}^0 e^{-(b'_{15})^{(1)}t} \le T_{15}(t) \le$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})} \left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t} \right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a'_{13})^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b'_{13})^{(1)}$ $(R_2)^{(1)} = (b'_{15})^{(1)} - (r_{15})^{(1)}$	290
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Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \le -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \le -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \le -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}((G_{19}), t) - (b''_{17})^{(2)}((G_{19}), t) \le -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0$, $(\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0$, $(u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}(u^{(2)})^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0$, $(\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0$, $(\bar{u}_2)^{(2)} < 0$ the	300

roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2+(\sigma_2)^{(2)}\nu^{(2)}-(a_{16})^{(2)}=0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2+(\tau_2)^{(2)}u^{(2)}-(b_{16})^{(2)}=0$	302
<u>Definition of</u> $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)}=(\nu_0)^{(2)}, (m_1)^{(2)}=(\nu_1)^{(2)}, \ \boldsymbol{if}\ (\nu_0)^{(2)}<(\nu_1)^{(2)}$	305
$(m_2)^{(2)}=(\nu_1)^{(2)}, (m_1)^{(2)}=(\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)}<(\nu_0)^{(2)}<(\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)}=(\nu_1)^{(2)}, (m_1)^{(2)}=(\nu_0)^{(2)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)}<(\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)}=(u_0)^{(2)}, (\mu_1)^{(2)}=(u_1)^{(2)}, \ \boldsymbol{if}\ (u_0)^{(2)}<(u_1)^{(2)}$ $(\mu_2)^{(2)}=(u_1)^{(2)}, (\mu_1)^{(2)}=(\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)}<(u_0)^{(2)}<(\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)}=\frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)}=(u_1)^{(2)}, (\mu_1)^{(2)}=(u_0)^{(2)}, \ \boldsymbol{if}\ (\bar{u}_1)^{(2)}<(u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t}-e^{-(S_2)^{(2)}t}\right]+G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t}-e^{-(a_{18}')^{(2)}t}\right]+G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t}-e^{-(b_{18}')^{(2)}t}\right]+T_{18}^0 e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$	315

$\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},\ \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321

and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ , \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
<u>**Behavior of the solutions of equation**</u> <u>**Theorem:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ $\boldsymbol{if}$ $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, $\boldsymbol{if}$ $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ $\boldsymbol{if}$ $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ $\boldsymbol{if}$ $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}$ $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)},$ $\boldsymbol{if}$ $(\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
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Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,	340

and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}, \ \boldsymbol{if} \ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}, \boldsymbol{if} \ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if} \ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
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$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
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Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
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$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \le G_{33}(t) \le \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \le G_{34}(t) \le\right.$ (a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t	355
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$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \le T_{32}(t) \le \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \le T_{34}(t) \le$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
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Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
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roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
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$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq \right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
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$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^0e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)},(S_2)^{(7)},(R_1)^{(7)},(R_2)^{(7)}$:- Where $(S_1)^{(7)}=(a_{36})^{(7)}(m_2)^{(7)}-(a_{36}^{'})^{(7)}$ $(S_2)^{(7)}=(a_{38})^{(7)}-(p_{38})^{(7)}$ $(R_1)^{(7)}=(b_{36})^{(7)}(\mu_2)^{(7)}-(b_{36}^{'})^{(7)}$ $(R_2)^{(7)}=(b_{38}^{'})^{(7)}-(r_{38})^{(7)}$	370
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$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$

$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$
and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$
and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	
($\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$ $\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a'_{46})^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a'_{46})^{(9)}t}] + G_{46}^0 e^{-(a'_{46})^{(9)}t}$)	
$T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b'_{46})^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b'_{46})^{(9)}t}\right] + T_{46}^0 e^{-(b'_{46})^{(9)}t} \leq T_{46}(t) \leq$ $\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a'_{44})^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b'_{44})^{(9)}$ $(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$	
Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right) - (a''_{14})^{(1)}(T_{14}, t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\nu^{(1)} = \frac{G_{13}}{G_{14}}$ It follows $-\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-	383

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have <u>**Definition of**</u> $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain <u>**Definition of**</u> $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	386

Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}$, $\boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390
In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393

If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}, \quad \boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}, \quad \boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)} G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)} T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21}, t)\right) - (a''_{21})^{(3)}(T_{21}, t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\quad \boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)}=\frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)}=\frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0<(\nu_1)^{(3)}<(\nu_0)^{(3)}=\frac{G_{20}^0}{G_{21}^0}<(\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0<(\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)}=\frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:- $(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t)=\frac{G_{20}(t)}{G_{21}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(3)}(t)$:- $(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t)=\frac{T_{20}(t)}{T_{21}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case :	403

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \le \frac{d\nu^{(4)}}{dt} \le -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \ge \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \le \nu^{(4)}(t) \le (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \le \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \le \nu^{(4)}(t) \le (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \le \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \le \nu^{(4)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \le (\bar{\nu}_1)^{(4)} \le \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \le \nu^{(4)}(t) \le \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

<u>Definition of</u> $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$**, and definition of** $(u_0)^{(5)}$.

<u>Proof</u> : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right) - (a_{33}'')^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

<u>Definition of</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\le\frac{d\nu^{(6)}}{dt}\le-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\ge\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\le\nu^{(6)}(t)\le(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\le\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\le\nu^{(6)}(t)\le(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\le\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\le\nu^{(6)}(t)\le$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\le(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\le(\bar{\nu}_1)^{(6)}\le\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\le\nu^{(6)}(t)\le\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\le(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\le\nu^{(6)}(t)\le(m_1)^{(6)},\quad\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\le u^{(6)}(t)\le(\mu_1)^{(6)},\quad\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**
Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \le \frac{d\nu^{(7)}}{dt} \le -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \ge \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \le \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \le \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \le \nu^{(7)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{36}'')^{(7)} = (a_{37}'')^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b_{36}'')^{(7)} = (b_{37}'')^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have
Definition of $\nu^{(8)}(t)$:-

$$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}, \quad \boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$$

In a completely analogous way, we obtain
Definition of $u^{(8)}(t)$:-

$$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}, \quad \boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .** Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.	
Proof : From 99,20,44,22,23,44 we obtain $$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}$, $\boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get $\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}$, $\boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$ From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$	
If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case, $(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$	

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain $(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(9)}(t)$:- $(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(9)}(t)$:- $(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$ Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem. **Particular case :** If $(a_{44}^{''})^{(9)} = (a_{45}^{''})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .** Analogously if $(b_{44}^{''})^{(9)} = (b_{45}^{''})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.	
We can prove the following **Theorem** : If $(a_i^{''})^{(1)} and\ (b_i^{''})^{(1)}$ are independent on t , and the conditions with the notations $(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$ $(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}^{'})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$ $(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}^{'})^{(1)}(r_{14})^{(1)} - (b_{14}^{'})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	425
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429

$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-(b_{16}^{'})^{(2)}(r_{17})^{(2)}-(b_{17}^{'})^{(2)}(r_{17})^{(2)}+(r_{16})^{(2)}(r_{17})^{(2)}<0$ $with\ (p_{16})^{(2)},(r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}<0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}+(a_{20})^{(3)}(p_{20})^{(3)}+(a_{21}^{'})^{(3)}(p_{21})^{(3)}+(p_{20})^{(3)}(p_{21})^{(3)}>0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}>0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-(b_{20}^{'})^{(3)}(r_{21})^{(3)}-(b_{21}^{'})^{(3)}(r_{21})^{(3)}+(r_{20})^{(3)}(r_{21})^{(3)}<0$ $with\ (p_{20})^{(3)},(r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}<0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}+(a_{24})^{(4)}(p_{24})^{(4)}+(a_{25}^{'})^{(4)}(p_{25})^{(4)}+(p_{24})^{(4)}(p_{25})^{(4)}>0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}>0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-(b_{24}^{'})^{(4)}(r_{25})^{(4)}-(b_{25}^{'})^{(4)}(r_{25})^{(4)}+(r_{24})^{(4)}(r_{25})^{(4)}<0$ $with\ (p_{24})^{(4)},(r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}<0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}+(a_{28})^{(5)}(p_{28})^{(5)}+(a_{29}^{'})^{(5)}(p_{29})^{(5)}+(p_{28})^{(5)}(p_{29})^{(5)}>0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}>0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-(b_{28}^{'})^{(5)}(r_{29})^{(5)}-(b_{29}^{'})^{(5)}(r_{29})^{(5)}+(r_{28})^{(5)}(r_{29})^{(5)}<0$ $with\ (p_{28})^{(5)},(r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}<0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}+(a_{32})^{(6)}(p_{32})^{(6)}+(a_{33}^{'})^{(6)}(p_{33})^{(6)}+(p_{32})^{(6)}(p_{33})^{(6)}>0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}>0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-(b_{32}^{'})^{(6)}(r_{33})^{(6)}-(b_{33}^{'})^{(6)}(r_{33})^{(6)}+(r_{32})^{(6)}(r_{33})^{(6)}<0$	434

with $(p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ *with* $(p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ *with* $(p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ *with* $(p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\,]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (q) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) + (a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)} G_{17}}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)} G_{17}}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^{*})]}$	499
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right] + (b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right] + (b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{25} such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{29} such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{33} such that $\varphi({G_{35}}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{37} such that $\varphi({G_{39}}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi({G_{43}}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}')^{(8)} - (b_{40}'')^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}')^{(8)} - (b_{42}'')^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt}=-\left((a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)\mathbb{G}_{17}+(a_{17})^{(2)}\mathbb{G}_{16}-(q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt}=-\left((a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)\mathbb{G}_{18}+(a_{18})^{(2)}\mathbb{G}_{17}-(q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt}=-\left((b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)\mathbb{T}_{16}+(b_{16})^{(2)}\mathbb{T}_{17}+\sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_{j}\right)$	537
$\frac{d\mathbb{T}_{17}}{dt}=-\left((b_{17}^{'})^{(2)}-(r_{17})^{(2)}\right)\mathbb{T}_{17}+(b_{17})^{(2)}\mathbb{T}_{16}+\sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_{j}\right)$	538
$\frac{d\mathbb{T}_{18}}{dt}=-\left((b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\mathbb{T}_{18}+(b_{18})^{(2)}\mathbb{T}_{17}+\sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_{j}\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad ,T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*})=(q_{21})^{(3)} \quad , \frac{\partial(b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*})=s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt}=-\left((a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\mathbb{G}_{20}+(a_{20})^{(3)}\mathbb{G}_{21}-(q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt}=-\left((a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)\mathbb{G}_{21}+(a_{21})^{(3)}\mathbb{G}_{20}-(q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt}=-\left((a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)\mathbb{G}_{22}+(a_{22})^{(3)}\mathbb{G}_{21}-(q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt}=-\left((b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)\mathbb{T}_{20}+(b_{20})^{(3)}\mathbb{T}_{21}+\sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_{j}\right)$	544
$\frac{d\mathbb{T}_{21}}{dt}=-\left((b_{21}^{'})^{(3)}-(r_{21})^{(3)}\right)\mathbb{T}_{21}+(b_{21})^{(3)}\mathbb{T}_{20}+\sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_{j}\right)$	545
$\frac{d\mathbb{T}_{22}}{dt}=-\left((b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\mathbb{T}_{22}+(b_{22})^{(3)}\mathbb{T}_{21}+\sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_{j}\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \;\; , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^* \;) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)} G_{24}^* \mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)} G_{25}^* \mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)} G_{26}^* \mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)} T_{24}^* \mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)} T_{25}^* \mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)} T_{26}^* \mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 5:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	555
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \;\; , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}(\,(G_{31})^*\,) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)} G_{28}^* \mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)} G_{29}^* \mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)} G_{30}^* \mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)} T_{28}^* \mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)} T_{29}^* \mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)} T_{30}^* \mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i'')^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G^*_{38}\,\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T^*_{36}\,\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T^*_{37}\,\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T^*_{38}\,\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}}(T^*_{41}) = (q_{41})^{(8)} \ , \ \frac{\partial (b''_i)^{(8)}}{\partial G_j}(\,(G_{43})^*\,) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G^*_{40}\,\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G^*_{41}\,\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)} G^*_{42}\,\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)} T^*_{40}\,\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)} T^*_{41}\,\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)} T^*_{42}\,\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(9)}$ *and* $(b''_i)^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{45})^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b''_i)^{(9)}}{\partial G_j}(\,(G_{47})^*\,) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a'_{44})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^*\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a'_{45})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^*\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a'_{46})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^*\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b'_{44})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^*\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b'_{45})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^*\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b'_{46})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^*\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b'_{15})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a'_{15})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a'_{14})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^* + (b_{14})^{(1)}s_{(13),(13)}T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left(\,(a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left(\,(b'_{13})^{(1)} + (b'_{14})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left(\,(a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$ $+\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$ +	

$((\lambda)^{(2)} + (b'_{18})^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a'_{18})^{(2)} + (p_{18})^{(2)})$

$\left[\left(((\lambda)^{(2)} + (a'_{16})^{(2)} + (p_{16})^{(2)})(q_{17})^{(2)}\mathrm{G}^*_{17} + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}^*_{16}\right)\right]$

$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)})s_{(17),(17)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}^*_{17}\right)$

$+\left(((\lambda)^{(2)} + (a'_{17})^{(2)} + (p_{17})^{(2)})(q_{16})^{(2)}\mathrm{G}^*_{16} + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}^*_{17}\right)$

$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)})s_{(17),(16)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}^*_{16}\right)$

$\left(((\lambda)^{(2)})^2 + ((a'_{16})^{(2)} + (a'_{17})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)})(\lambda)^{(2)}\right)$

$\left(((\lambda)^{(2)})^2 + ((b'_{16})^{(2)} + (b'_{17})^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)})(\lambda)^{(2)}\right)$

$+\left(((\lambda)^{(2)})^2 + ((a'_{16})^{(2)} + (a'_{17})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)})(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+((\lambda)^{(2)} + (a'_{16})^{(2)} + (p_{16})^{(2)})\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}^*_{17} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}^*_{16}\right)$

$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)})s_{(17),(18)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}^*_{16}\right)\} = 0$

+

$((\lambda)^{(3)} + (b'_{22})^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a'_{22})^{(3)} + (p_{22})^{(3)})$

$\left[\left(((\lambda)^{(3)} + (a'_{20})^{(3)} + (p_{20})^{(3)})(q_{21})^{(3)}G^*_{21} + (a_{21})^{(3)}(q_{20})^{(3)}G^*_{20}\right)\right]$

$\left(((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)})s_{(21),(21)}T^*_{21} + (b_{21})^{(3)}s_{(20),(21)}T^*_{21}\right)$

$+\left(((\lambda)^{(3)} + (a'_{21})^{(3)} + (p_{21})^{(3)})(q_{20})^{(3)}G^*_{20} + (a_{20})^{(3)}(q_{21})^{(1)}G^*_{21}\right)$

$\left(((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)})s_{(21),(20)}T^*_{21} + (b_{21})^{(3)}s_{(20),(20)}T^*_{20}\right)$

$\left(((\lambda)^{(3)})^2 + ((a'_{20})^{(3)} + (a'_{21})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)})(\lambda)^{(3)}\right)$

$\left(((\lambda)^{(3)})^2 + ((b'_{20})^{(3)} + (b'_{21})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)})(\lambda)^{(3)}\right)$

$+\left(((\lambda)^{(3)})^2 + ((a'_{20})^{(3)} + (a'_{21})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)})(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$

$+((\lambda)^{(3)} + (a'_{20})^{(3)} + (p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G^*_{21} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G^*_{20}\right)$

$\left(((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)})s_{(21),(22)}T^*_{21} + (b_{21})^{(3)}s_{(20),(22)}T^*_{20}\right)\} = 0$

+

$$((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)})$$

$$\left[\left(((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$$

$$\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$$

$$+\left(((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$$

$$\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$$

$$\left(((\lambda)^{(4)})^{2} + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$$

$$\left(((\lambda)^{(4)})^{2} + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$$

$$+\left(((\lambda)^{(4)})^{2} + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$$

$$+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$$

$$\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$$

+

$$((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)})$$

$$\left[\left(((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$$

$$\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$$

$$+\left(((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(((\lambda)^{(5)})^{2} + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$\left(((\lambda)^{(5)})^{2} + \left((b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$+\left(((\lambda)^{(5)})^{2} + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(30)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\} = 0$$

+

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$((\lambda)^{(8)} + (b'_{42})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a'_{42})^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(q_{40})^{(8)}G^*_{40}\right)\right]$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T^*_{41} + (b_{41})^{(8)}s_{(40),(41)}T^*_{41}\right)$$

$$+\left(((\lambda)^{(8)} + (a'_{41})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G^*_{40} + (a_{40})^{(8)}(q_{41})^{(8)}G^*_{41}\right)$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T^*_{41} + (b_{41})^{(8)}s_{(40),(40)}T^*_{40}\right)$$

$$\left(((\lambda)^{(8)})^2 + \left((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(((\lambda)^{(8)})^2 + \left((b'_{40})^{(8)} + (b'_{41})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(((\lambda)^{(8)})^2 + \left((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G^*_{40}\right)$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T^*_{41} + (b_{41})^{(8)}s_{(40),(42)}T^*_{40}\right)\} = 0$$

$+$

$$((\lambda)^{(9)} + (b'_{46})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a'_{46})^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(q_{44})^{(9)}G^*_{44}\right)\right]$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T^*_{45} + (b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$$

$$+\left(((\lambda)^{(9)} + (a'_{45})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G^*_{44} + (a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T^*_{45} + (b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$$

$$\left(((\lambda)^{(9)})^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$\left(((\lambda)^{(9)})^2 + \left((b'_{44})^{(9)} + (b'_{45})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$+\left(((\lambda)^{(9)})^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T^*_{45} + (b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\} = 0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.	

SECTION EIGHTEEN

Spacetime Symmetries Of The Quantum Hall Effect

INTRODUCTION—VARIABLES USED

Spacetime Symmetries of the Quantum Hall Effect Michael Geracie, Dam Thanh Son, Chaolun Wu, Shao-Feng Wu

(1) Authors study the symmetries of non-relativistic systems with (e&eb) an emphasis on applications to (e&eb) the fractional quantum Hall Effect.
(2) A source for the energy current of (e) a Galilean system is introduced and (e&eb) the non-relativistic diffeomorphism invariance studied in previous work is enhanced to (e&eb) full spacetime symmetry, allowing us (eb) to derive a number of Ward identities.
(3) These symmetries are smooth in (eb) the massless limit of (e) the lowest Landau level.
(4) They develop formalism for (e) Newton-Cartan geometry with (e&eb) torsion to write these Ward identities in a covariant form.
(5) Previous results on the connection between Hall viscosity and (e&eb)Hall conductivity are reproduced. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); High Energy Physics - Theory (hep-th) Journal reference: Phys. Rev. D 91, 045030 (2015) DOI: 10.1103/PhysRevD.91.045030 Cite as: arXiv:1407.1252 [cond-mat.mes-hall] (or arXiv:1407.1252v2 [cond-mat.mes-hall] for this version)

Deformations of the spin currents by topological screw dislocation and cosmic dispiration Jian-hua Wang, Kai Ma, Kang Li, Hua-wei Fan

We study the spin currents induced by topological screw dislocation and cosmic dispiration. By using the extended Drude model, we find that the spin dependent forces are modified by the nontrivial geometry. For the topological screw dislocation, only the direction of spin current is bended by deforming the spin polarization vector. In contrast, the force induced by cosmic dispiration could affect both the direction and magnitude of the spin current. As a consequence, the spin-Hall conductivity doesn't receive corrections from screw dislocation. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); General Relativity and Quantum Cosmology (gr-qc); Quantum Physics (quant-ph) Journal reference: Ann. Phys. 362, 327(2015) DOI: 10.1016/j.aop.2015.08.004 Cite as: arXiv: 1510.07741 [cond-mat.mes-hall] (or arXiv:1510.07741v1 [cond-mat.mes-hall] for this version

NOTATION

Module One

Transport phenomena and (e&eb) thermodynamics of non-relativistic fluids.

G_{13} : Category one of **transport phenomena;** thermodynamics of non-relativistic fluids

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of thermodynamics of non-relativistic fluids **;transport phenomena**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Authors study the symmetries of non-relativistic systems with (e&eb) an emphasis on applications to (e&eb) the fractional quantum Hall Effect

G_{16} : Category one of **symmetries of non-relativistic systems;** emphasis on applications to (e&eb) the fractional quantum Hall Effect

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of emphasis on applications to (e&eb) the fractional quantum Hall Effect **;symmetries of non-relativistic systems**

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

Authors study the symmetries of non-relativistic systems with an emphasis on applications to (e&eb) the fractional quantum Hall Effect

G_{20} : Category one of **symmetries of non-relativistic systems with an emphasis on applications;** fractional quantum Hall Effect

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of fractional quantum Hall Effect ;**symmetries of non-relativistic systems with an emphasis on applications**

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

A source for the energy current of (e) a Galilean system is introduced and (e&eb) the non-relativistic diffeomorphism invariance studied in previous work is enhanced to (e&eb) full spacetime symmetry, allowing us (eb) to derive a number of Ward identities

G_{24} : Category one of **source for the energy current;** Galilean system is introduced and (e&eb) the non-relativistic diffeomorphism invariance studied in previous work is enhanced to (e&eb) full spacetime symmetry, allowing us (eb) to derive a number of Ward identities

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of Galilean system is introduced and (e&eb) the non-relativistic diffeomorphism invariance studied in previous work is enhanced to (e&eb) full spacetime symmetry, allowing us (eb) to derive a number of Ward identities; **source for the energy current**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

A source for the energy current of a Galilean system is introduced and (e&eb) the non-relativistic diffeomorphism invariance studied in previous work is enhanced to (e&eb) full spacetime symmetry, allowing us (eb) to derive a number of Ward identities

G_{28} : Category one of **energy current of a Galilean system;** non-relativistic diffeomorphism invariance studied in previous work is enhanced to (e&eb) full spacetime symmetry, allowing us (eb) to derive a number of Ward identities

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of non-relativistic diffeomorphism invariance studied in previous work is enhanced to (e&eb) full spacetime symmetry, allowing us (eb) to derive a number of Ward identities **;energy current of a Galilean system**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

A source for the energy current of a Galilean system is introduced and the non-relativistic diffeomorphism invariance studied in previous work is enhanced to (e&eb) full spacetime symmetry, allowing us (eb) to derive a number of Ward identities

G_{32} : Category one of **source for the energy current of a Galilean system is introduced and the non-relativistic diffeomorphism invariance studied in previous work is enhanced;** full spacetime symmetry, allowing us (eb) to derive a number of Ward identities

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of full spacetime symmetry, allowing us (eb) to derive a number of Ward identities

;source for the energy current of a Galilean system is introduced and the non-relativistic diffeomorphism invariance studied in previous work is enhanced

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

A source for the energy current of a Galilean system is introduced and the non-relativistic diffeomorphism invariance studied in previous work is enhanced to full spacetime symmetry, allowing us (eb) to derive a number of Ward identities

G_{36} : Category one of source for the energy current of a Galilean system is introduced and the non-relativistic diffeomorphism invariance studied in previous work is enhanced to full spacetime symmetry

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of derive a number of Ward identities

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

These symmetries are smooth in (eb) the massless limit of (e) the lowest Landau level

G_{40} : Category one of symmetries are smooth; **massless limit of the lowest Landau level**

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of **massless limit of the lowest Landau level;** symmetries are smooth

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

They develop formalism for Newton-Cartan geometry with (e&eb) **torsion to write these Ward identities in a covariant form**

G_{44} : Category one of formalism Newton-Cartan geometry; **torsion to write these Ward identities in a covariant form**

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of **torsion to write these Ward identities in a covariant form** ;formalism Newton-Cartan geometry

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t)\right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t)\right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t)\right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t)\right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t)\right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}, t)\right] G_{17}$	8

$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}, t)\right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}), t\right)\right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}), t\right)\right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}), t\right)\right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}), t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}, t)\right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}, t)\right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}, t)\right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}, t)\right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}, t)\right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}, t)\right] T_{22}$	18
$+(a''_{20})^{(3)}(T_{21}, t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23}, t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}, t)\right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}, t)\right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27}), t\right)\right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27}), t\right)\right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27}), t\right)\right] T_{26}$	24
$+(a''_{24})^{(4)}(T_{25}, t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)}\left((G_{27}), t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}, t)\right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}, t)\right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\left((G_{31}), t\right)\right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\left((G_{31}), t\right)\right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\left((G_{31}), t\right)\right] T_{30}$	30

$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}\big((G_{31}),t\big) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\big((G_{35}),t\big)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\big((G_{35}),t\big)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\big((G_{35}),t\big)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\big((G_{39}),t\big)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\big((G_{39}),t\big)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\big((G_{39}),t\big)\right]T_{38}$	*42*
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\big((G_{43}),t\big)\right]T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\big((G_{43}),t\big)\right]T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\big((G_{43}),t\big)\right]T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51

$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)} \left((G_{47}), t \right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)} \left((G_{47}), t \right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)} \left((G_{47}), t \right) \right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}), t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*55*
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	*56*
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	*57*
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58

$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[\begin{matrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[\begin{matrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{16}$	*61*
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{17}$	*62*
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{18}$	*63*
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$+(a''_{13})^{(1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,)}(T_{14},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3 $+(a''_{44})^{(9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9)}(T_{45},t)$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[\begin{matrix}(b'_{16})^{(2)}-(b''_{16})^{(2)}(G_{19},t)-(b''_{13})^{(1,1,)}(G,t)-(b''_{20})^{(3,3,3,)}(G_{23},t)\\-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)\\-(b''_{36})^{(7,7,7)}(G_{39},t)-(b''_{40})^{(8,8,8)}(G_{43},t)-(b''_{44})^{(9,9)}(G_{47},t)\end{matrix}\right]T_{16}$	64
$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[\begin{matrix}(b'_{17})^{(2)}-(b''_{17})^{(2)}(G_{19},t)-(b''_{14})^{(1,1,)}(G,t)-(b''_{21})^{(3,3,3,)}(G_{23},t)\\-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)\\-(b''_{37})^{(7,7,7)}(G_{39},t)-(b''_{41})^{(8,8,8)}(G_{43},t)-(b''_{45})^{(9,9)}(G_{47},t)\end{matrix}\right]T_{17}$	65
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[\begin{matrix}(b'_{18})^{(2)}-(b''_{18})^{(2)}(G_{19},t)-(b''_{15})^{(1,1,)}(G,t)-(b''_{22})^{(3,3,3,)}(G_{23},t)\\-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)\\-(b''_{38})^{(7,7,7)}(G_{39},t)-(b''_{42})^{(8,8,8)}(G_{43},t)-(b''_{46})^{(9,9)}(G_{47},t)\end{matrix}\right]T_{18}$	66
where $-(b''_{16})^{(2)}(G_{19},t)$, $-(b''_{17})^{(2)}(G_{19},t)$, $-(b''_{18})^{(2)}(G_{19},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{13})^{(1,1,)}(G,t)$, $-(b''_{14})^{(1,1,)}(G,t)$, $-(b''_{15})^{(1,1,)}(G,t)$ are second detrition coefficients for category 1,2 and 3 $-(b''_{20})^{(3,3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,)}(G_{23},t)$ are third detrition coefficients for category 1,2 and 3 $-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1,2 and 3 $-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1,2 and 3 $-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1,2 and 3	

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20}$	70

$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21}$	71
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22}$	72
$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3* $\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24}$	73
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25}$	74
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$	75
$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category$ 1, 2 3 $\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation*	

$coefficient\ \ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ \ augmentation$

$coefficient\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$

$are\ fourth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$

$are\ fifth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$

$are\ sixth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$

$are\ seventh\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$

$are\ eighth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[\begin{matrix}(b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{24}$$ 76

$$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\left[\begin{matrix}(b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{25}$$ 77

$$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\left[\begin{matrix}(b'_{26})^{(4)}\boxed{-(b''_{26})^{(4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{26}$$ 78

$Where$ $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ $are\ first\ detrition\ coefficients$

$for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ $are\ second\ detrition\ coefficients$

$for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$

$for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

$are\ fourth\ \ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

$are\ fifth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

$are\ sixth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

$are\ seventh\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b_{40}'')^{(8,8,8,8,8)}(G_{43},t)}, \boxed{-(b_{41}'')^{(8,8,8,8,8)}(G_{43},t)}, \boxed{-(b_{42}'')^{(8,8,8,8,8)}(G_{43},t)}$ $are\ eighth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b_{46}'')^{(9,9,9,9)}(G_{47},t)}, \boxed{-(b_{45}'')^{(9,9,9,9)}(G_{47},t)}, \boxed{-(b_{44}'')^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a_{28}')^{(5)} \boxed{+(a_{28}'')^{(5)}(T_{29},t)} \boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a_{29}')^{(5)} \boxed{+(a_{29}'')^{(5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a_{30}')^{(5)} \boxed{+(a_{30}'')^{(5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
$Where\ \boxed{+(a_{28}'')^{(5)}(T_{29},t)}, \boxed{+(a_{29}'')^{(5)}(T_{29},t)}, \boxed{+(a_{30}'')^{(5)}(T_{29},t)}\ are\ first\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $And\ \boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)}, \boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)}, \boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)}\ are\ second\ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)}, \boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)}, \boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)}\ are\ third\ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)}, \boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)}, \boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)}, \boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)}, \boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)}, \boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)}, \boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)}, \boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)}, \boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b_{28}')^{(5)} \boxed{-(b_{28}'')^{(5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{32}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$	82

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31},t) & -(b''_{25})^{(4,4,)}(G_{27},t) & -(b''_{33})^{(6,6,6)}(G_{35},t) \\ -(b''_{14})^{(1,1,1,1,1)}(G,t) & -(b''_{17})^{(2,2,2,2,2)}(G_{19},t) & -(b''_{21})^{(3,3,3,3,3)}(G_{23},t) \\ -(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t) & -(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t) & -(b''_{45})^{(9,9,9,9,9)}(G_{47},t) \end{matrix} \right] T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31},t) & -(b''_{26})^{(4,4,)}(G_{27},t) & -(b''_{34})^{(6,6,6)}(G_{35},t) \\ -(b''_{15})^{(1,1,1,1,1,)}(G,t) & -(b''_{18})^{(2,2,2,2,2)}(G_{19},t) & -(b''_{22})^{(3,3,3,3,3)}(G_{23},t) \\ -(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t) & -(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t) & -(b''_{46})^{(9,9,9,9,9)}(G_{47},t) \end{matrix} \right] T_{30} \quad 84$$

where $-(b''_{28})^{(5)}(G_{31},t)$, $-(b''_{29})^{(5)}(G_{31},t)$, $-(b''_{30})^{(5)}(G_{31},t)$ *are first detrition coefficients for category* 1, 2 *and* 3

$-(b''_{24})^{(4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,)}(G_{27},t)$ *are second detrition coefficients for category* 1,2 *and* 3

$-(b''_{32})^{(6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6)}(G_{35},t)$ *are third detrition coefficients for category* 1,2 *and* 3

$-(b''_{13})^{(1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1)}(G,t)$, $-(b''_{15})^{(1,1,1,1,1,)}(G,t)$ are fourth detrition coefficients for category 1,2, and 3

$-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)$ are fifth detrition coefficients for category 1,2, and 3

$-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1,2, and 3

$-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2, and 3

$-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1,2, and 3

$-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[\begin{matrix} (a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t) & +(a''_{28})^{(5,5,5)}(T_{29},t) & +(a''_{24})^{(4,4,4,)}(T_{25},t) \\ +(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t) & +(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t) & +(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t) & +(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t) & +(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t) \end{matrix} \right] G_{32} \quad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t) & +(a''_{29})^{(5,5,5)}(T_{29},t) & +(a''_{25})^{(4,4,4,)}(T_{25},t) \\ +(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t) & +(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t) & +(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t) & +(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t) & +(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t) \end{matrix} \right] G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t) & +(a''_{30})^{(5,5,5)}(T_{29},t) & +(a''_{26})^{(4,4,4,)}(T_{25},t) \\ +(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t) & +(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t) & +(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t) & +(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t) & +(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t) \end{matrix} \right] G_{34} \quad 87$$

$+(a''_{32})^{(6)}(T_{33},t)$, $+(a''_{33})^{(6)}(T_{33},t)$, $+(a''_{34})^{(6)}(T_{33},t)$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\left[\begin{matrix}(b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{32}$	*88*
$\frac{dT_{33}}{dt}=(b_{33})^{(6)}T_{32}-\left[\begin{matrix}(b'_{33})^{(6)}\boxed{-(b''_{33})^{(6)}(G_{35},t)}\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{33}$	*89*
$\frac{dT_{34}}{dt}=(b_{34})^{(6)}T_{33}-\left[\begin{matrix}(b'_{34})^{(6)}\boxed{-(b''_{34})^{(6)}(G_{35},t)}\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{34}$	*90*
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3	

$-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1, 2, and 3 $-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2, and 3 $-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2, and 3 $-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t) + (a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t) + (a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t) + (a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t) + (a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t) + (a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{14}$	92
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t) + (a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t) + (a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{15}$	93
Where $(a''_{36})^{(7)}(T_{37},t)$, $(a''_{37})^{(7)}(T_{37},t)$, $(a''_{38})^{(7)}(T_{37},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)$ are eighth augmentation coefficient for 1,2,3	

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$\frac{dT_{40}}{dt} =$

$$(b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b_{40}^{'})^{(8)}\boxed{-(b_{40}^{''})^{(8)}(G_{43},t)} & \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$	
$$\frac{dT_{41}}{dt} =$$ $$(b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b_{41}^{'})^{(8)}\boxed{-(b_{41}^{''})^{(8)}(G_{43},t)} & \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$	
$$\frac{dT_{42}}{dt} =$$ $$(b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b_{42}^{'})^{(8)}\boxed{-(b_{42}^{''})^{(8)}(G_{43},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$	
Where $\boxed{-(b_{36}^{''})^{(7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a_{44}^{'})^{(9)}\boxed{+(a_{44}^{''})^{(9)}(T_{45},t)} & \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{13}$$	96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$(b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b_{45}^{'})^{(9)} \boxed{-(b_{45}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{46}}{dt} =$ $(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i^{''})^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i^{''})^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b_i^{'})^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2 \to \infty} (a_i^{''})^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b_i^{''})^{(1)} (G,t) = \ (r_i)^{(1)}$	98

Definition of $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$:

Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$

They satisfy Lipschitz condition: 99

$$|(a_i'')^{(1)}(T_{14}', t) - (a_i'')^{(1)}(T_{14}, t)| \leq (\hat{k}_{13})^{(1)}|T_{14} - T_{14}'|e^{-(\hat{M}_{13})^{(1)}t}$$

$$|(b_i'')^{(1)}(G', t) - (b_i'')^{(1)}(G, t)| < (\hat{k}_{13})^{(1)}||G - G'||e^{-(\hat{M}_{13})^{(1)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}', t)$ and $(a_i'')^{(1)}(T_{14}, t)$. (T_{14}', t) and (T_{14}, t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: 100

$(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants

$$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$$

Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: 101

There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{13})^{(1)}}[\, (a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$$

$$\frac{1}{(\hat{M}_{13})^{(1)}}[\, (b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$$

Where we suppose

$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i, j = 16,17,18$

The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.

Definition of $(\mathrm{p_i})^{(2)}, \ (\mathrm{r_i})^{(2)}$:

$$(a_i'')^{(2)}(T_{17}, t) \leq (p_i)^{(2)} \leq \left(\hat{A}_{16}\right)^{(2)}$$ 102

$$(b_i'')^{(2)}(G_{19}, t) \leq \ (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$$ 103

$$\lim_{T_2 \to \infty} (a_i'')^{(2)} (T_{17}, t) = (p_i)^{(2)}$$ 104

$$\lim_{G \to \infty} (b_i'')^{(2)} \left((G_{19}), t\right) = \ (r_i)^{(2)}$$ 105

Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert (a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t) \rvert \leq (\hat{k}_{16})^{(2)} \lvert T_{17} - T_{17}' \rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert (b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}((G_{19}),t) \rvert < (\hat{k}_{16})^{(2)} \lvert\lvert (G_{19}) - (G_{19})' \rvert\lvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i')^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, (r_i)^{(3)}$: $(a_i'')^{(3)}(T_{21},t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t) \leq (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
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They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}',t) - (a_i'')^{(3)}(T_{21},t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}',t) - (b_i'')^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and $(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}\left((G_{27}),t\right) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
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Definition of $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}},\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
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Where we suppose	
(YYYY) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (ZZZZ) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, \ (r_i)^{(7)}$:	131

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$(b_i^{''})^{(7)}(G_{39},t) \leq (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$

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(AAAAA) $\lim_{T_2 \to \infty} (a_i^{''})^{(7)}(T_{37},t) = (p_i)^{(7)}$

(BBBBB)

$\lim_{G \to \infty} (b_i^{''})^{(7)}((G_{39}),t) = (r_i)^{(7)}$

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$:

Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$

They satisfy Lipschitz condition: 133

$|(a_i^{''})^{(7)}(T_{37}^{'},t) - (a_i^{''})^{(7)}(T_{37},t)| \leq (\hat{k}_{36})^{(7)}|T_{37} - T_{37}^{'}|e^{-(\hat{M}_{36})^{(7)}t}$

$|(b_i^{''})^{(7)}((G_{39})^{'},t) - (b_i^{''})^{(7)}((G_{39}),t)| < (\hat{k}_{36})^{(7)}||(G_{39}) - (G_{39})^{'}||e^{-(\hat{M}_{36})^{(7)}t}$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'},t)$ and $(a_i^{''})^{(7)}(T_{37},t)$. $(T_{37}^{'},t)$ and (T_{37},t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: 134

(CCCCC) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants

$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$

Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: 135

(DDDDD) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities

$$\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i^{'})^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$$

$$\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i^{'})^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$$

Where we suppose

$(a_i)^{(8)}, (a_i^{'})^{(8)}, (a_i^{''})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (b_i^{''})^{(8)} > 0, \quad i,j = 40,41,42$	136
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Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities	

$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$	
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{13}\left(s_{(13)}\right) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}\left(s_{(13)}\right) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{14}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{15}\left(s_{(13)}\right) \right] ds_{(13)}$	

$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{16})^{(2)}, T_i^0 \le (\hat{Q}_{16})^{(2)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{20})^{(3)}, T_i^0 \le (\hat{Q}_{20})^{(3)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a'_{20})^{(3)} + a''_{20})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \ , \ T_i(0) = T_i^0 \ , \ G_i^0 \leq (\ \hat{P}_{28}\ )^{(5)} \ , T_i^0 \leq (\ \hat{Q}_{28}\ )^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{28}\ )^{(5)} e^{(\ \hat{M}_{28}\ )^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{28}\ )^{(5)} e^{(\ \hat{M}_{28}\ )^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i \ , \ T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \ , \ T_i(0) = T_i^0 \ , \ G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)} \ , T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	

$\overline{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}\left(s_{(32)}\right) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left(G_{35}\left(s_{(32)}\right), s_{(32)}\right)\right) T_{34}\left(s_{(32)}\right)\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{36})^{(7)}, T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{36}\left(s_{(36)}\right)\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}\left(s_{(36)}\right) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{37}\left(s_{(36)}\right)\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{38}\left(s_{(36)}\right)\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left(G_{39}\left(s_{(36)}\right), s_{(36)}\right)\right) T_{36}\left(s_{(36)}\right)\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}\left(s_{(36)}\right) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left(G_{39}\left(s_{(36)}\right), s_{(36)}\right)\right) T_{37}\left(s_{(36)}\right)\right] ds_{(36)}$	
$\overline{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left(G_{39}\left(s_{(36)}\right), s_{(36)}\right)\right) T_{38}\left(s_{(36)}\right)\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{46}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{46}(s_{(44)}) \right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	167

$G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0 \right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0} \right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}} \right) \right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1 \right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0 \right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0} \right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	171
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$d\left(\left(G^{(1)},T^{(1)}\right),\left(G^{(2)},T^{(2)}\right)\right)=$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\hat{M}_{13})^{(1)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\hat{M}_{13})^{(1)}t}\}$$

Indeed if we denote

Definition of $\tilde{G},\tilde{T}$: $(\tilde{G},\tilde{T})=\mathcal{A}^{(1)}(G,T)$

It results

$$\left|\tilde{G}_{13}^{(1)}-\tilde{G}_i^{(2)}\right|\le\int_0^t(a_{13})^{(1)}\left|G_{14}^{(1)}-G_{14}^{(2)}\right|e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{(\widehat{M}_{13})^{(1)}s_{(13)}}\,ds_{(13)}+$$

$$\int_0^t\{(a_{13}')^{(1)}\left|G_{13}^{(1)}-G_{13}^{(2)}\right|e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}+$$

$$(a_{13}'')^{(1)}\left(T_{14}^{(1)},s_{(13)}\right)\left|G_{13}^{(1)}-G_{13}^{(2)}\right|e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{(\widehat{M}_{13})^{(1)}s_{(13)}}+$$

$$G_{13}^{(2)}|(a_{13}'')^{(1)}\left(T_{14}^{(1)},s_{(13)}\right)-(a_{13}'')^{(1)}\left(T_{14}^{(2)},s_{(13)}\right)|\;e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{(\widehat{M}_{13})^{(1)}s_{(13)}}\}ds_{(13)}$$

Where $s_{(13)}$ represents integrand that is integrated over the interval $[0,t]$

From the hypotheses it follows

$$\left|G^{(1)}-G^{(2)}\right|e^{-(\widehat{M}_{13})^{(1)}t}\le\frac{1}{(\widehat{M}_{13})^{(1)}}\left((a_{13})^{(1)}+(a_{13}')^{(1)}+(\widehat{A}_{13})^{(1)}+(\widehat{P}_{13})^{(1)}(\widehat{k}_{13})^{(1)}\right)d\left(\left(G^{(1)},T^{(1)};\;G^{(2)},T^{(2)}\right)\right)$$ 186

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

<u>Remark 1:</u> The fact that we supposed $(a_{13}'')^{(1)}$ and $(b_{13}'')^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ *and* $(\widehat{Q}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(1)}$ and $(b_i'')^{(1)}, i=13,14,15$ depend only on T_{14} and respectively on $G(\text{and not on } t)$ and hypothesis can replaced by a usual Lipschitz condition.

<u>Remark 2:</u> There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$

From 19 to 24 it results

$$G_i(t)\ge G_i^0e^{\left[-\int_0^t\{(a_i')^{(1)}-(a_i'')^{(1)}(T_{14}(s_{(13)}),s_{(13)})\}ds_{(13)}\right]}\ge0$$

$$T_i(t)\ge T_i^0e^{(-(b_i')^{(1)}t)}>0\quad\text{for } t>0$$

<u>Definition of</u> $\left((\widehat{M}_{13})^{(1)}\right)_1,\left((\widehat{M}_{13})^{(1)}\right)_2$ *and* $\left((\widehat{M}_{13})^{(1)}\right)_3$: 187

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The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(((G_{39})^{(1)},(T_{39})^{(1)}),((G_{39})^{(2)},(T_{39})^{(2)})\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{36})^{(7)}t}\}$ Indeed if we denote **<u>Definition of</u>** $\widetilde{(G_{39})},\widetilde{(T_{39})}:(\widetilde{(G_{39})},\widetilde{(T_{39})})=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$ It results $\lvert\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}\rvert\leq\int_0^t(a_{36})^{(7)}\lvert G_{37}^{(1)}-G_{37}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}ds_{(36)}+$ $\int_0^t\{(a_{36}')^{(7)}\lvert G_{36}^{(1)}-G_{36}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{-(\hat{M}_{36})^{(7)}s_{(36)}}+$ $(a_{36}'')^{(7)}(T_{37}^{(1)},s_{(36)})\lvert G_{36}^{(1)}-G_{36}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}+$ $G_{36}^{(2)}\lvert(a_{36}'')^{(7)}(T_{37}^{(1)},s_{(36)})-(a_{36}'')^{(7)}(T_{37}^{(2)},s_{(36)})\rvert\ e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,t]$ From the hypotheses on it follows	258
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$d\left(((G_{43})^{(1)},(T_{43})^{(1)}),((G_{43})^{(2)},(T_{43})^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
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condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ *and* $(\hat{Q}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	
Remark 37 There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)} - (a_i'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)} t)} > 0$ for $t > 0$	275
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$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right)$, $t = log \frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b''_{42})^{(8)}\left((G_{43})(t),t(t),t\right) = (b'_{42})^{(8)}$	
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\mathcal{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\mathcal{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + ((\widehat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$	
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In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(\left((G_{47})^{(1)},(T_{47})^{(1)}\right),\left((G_{47})^{(2)},(T_{47})^{(2)}\right)\right) = \sup_i\{\max_{t\in\mathbb{R}_+}\|G_i^{(1)}(t) - G_i^{(2)}(t)\|e^{-(\widehat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}\|T_i^{(1)}(t) - T_i^{(2)}(t)\|e^{-(\widehat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})},\widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}),(T_{47})\right)$ It results $\|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\| \leq \int_0^t (a_{44})^{(9)}\|G_{45}^{(1)} - G_{45}^{(2)}\|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}ds_{(44)} + \int_0^t\{(a'_{44})^{(9)}\|G_{44}^{(1)} - G_{44}^{(2)}\|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} + (a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})\|G_{44}^{(1)} - G_{44}^{(2)}\|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}} + G_{44}^{(2)}\|(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)}) - (a''_{44})^{(9)}(T_{45}^{(2)},s_{(44)})\|\ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$ Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on 45,46,47,28 and 29 it follows	
$\|(G_{47})^{(1)} - G^{(2)}\|e^{-(\widehat{M}_{44})^{(9)}t} \leq \frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows	
Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by	

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ and $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ and $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t\{(a_i')^{(9)}-(a_i'')^{(9)}(T_{45}(s_{(44)}),s_{(44)})\}ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ and $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} and G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)}G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1/(a_{45}')^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2/(a_{46}')^{(9)}$

If G_{45} or G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} is bounded, from below, the same property holds for G_{45} and G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t),t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t),t) = (b_{46}')^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying

$$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$$

$$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G, t) - (b_{14}^{''})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$$

Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: 281

By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(\bar{\nu}_1)^{(1)}, , (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: 282

By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- 283

If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by

$$(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \; if \; (\nu_0)^{(1)} < (\nu_1)^{(1)}$$

$$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \; (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$$

and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$

$$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)}, \; if \; (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$$

and analogously 284

$$(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)}, \; if \; (u_0)^{(1)} < (u_1)^{(1)}$$

$$(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if \; (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$$

and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$

$(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if \; (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$

are defined

Then the solution of global equations satisfies the inequalities 285

$$G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$$

where $(p_i)^{(1)}$ is defined by equation

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}^{'})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}^{'})^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}^{'})^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
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$\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	
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Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
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and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}, \; \boldsymbol{if} \; (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)} \,, \boldsymbol{if} \; (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}, \; \boldsymbol{if} \; (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)} t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)} t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})} \left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)} t} \right] + G_{22}^0 e^{-(S_2)^{(3)} t} \leq G_{22}(t) \leq \right.$ $\left. \frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a'_{22})^{(3)})} [e^{(S_1)^{(3)} t} - e^{-(a'_{22})^{(3)} t}] + G_{22}^0 e^{-(a'_{22})^{(3)} t} \right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)} t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)} t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
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<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)} (m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)} (\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
<u>**Behavior of the solutions of equation**</u> <u>**Theorem:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, $\boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \le T_{24}(t) \le T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \le T_{24}(t) \le \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}^{'})^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}^{'})^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}^{'})^{(4)}t} \le T_{26}(t) \le$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}^{'})^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}^{'})^{(4)}$ $(R_2)^{(4)} = (b_{26}^{'})^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \le -(a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} - (a_{28}^{''})^{(5)}(T_{29}, t) + (a_{29}^{''})^{(5)}(T_{29}, t) \le -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \le -(b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (b_{28}^{''})^{(5)}\big((G_{31}), t\big) - (b_{29}^{''})^{(5)}\big((G_{31}), t\big) \le -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,	340

and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)}G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}}$	345
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$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
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$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$

$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \; \boldsymbol{if} \; (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \; (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,
and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \; \boldsymbol{if} \; (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \; (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,
and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \; (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t})$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{dv^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)v^{(1)} - (a_{14})^{(1)}v^{(1)}$$

Definition of $v^{(1)}$:- $\boxed{v^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_2)^{(1)}v^{(1)} - (a_{13})^{(1)}\right) \leq \frac{dv^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(v^{(1)}\right)^2 + (\sigma_1)^{(1)}v^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right) t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right) t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right) t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right) t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
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If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
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And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}$, $\boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$ From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$	
If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, $(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$	410
If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain $(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(5)}(t)$:- $(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}$, $\boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(5)}(t)$:- $(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	411
Proof : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ **Definition of** $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$	412

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)}$, $\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)}$, $\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \le \frac{d\nu^{(7)}}{dt} \le -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \ge \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \le \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \le \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \le \nu^{(7)}(t) \le$$

$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420
Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$	421

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}, \quad \boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}, \quad \boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$**, and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain $(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right) t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right) t\right]}} \leq (\nu_0)^{(9)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(9)}(t)$:- $(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(9)}(t)$:- $(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$ Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem. **Particular case :** If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .** Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$ if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.	
We can prove the following **Theorem** : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations $(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$ $(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$ $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	425
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i'')^{(3)} and\ (b_i'')^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i'')^{(4)} and\ (b_i'')^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i'')^{(5)} and\ (b_i'')^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i'')^{(6)} and\ (b_i'')^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

$with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\ ]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (r) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) + (a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	499
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Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$	501
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By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right] + (b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
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By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
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By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi({G_{43}}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt}=-\left((a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)\mathbb{G}_{17}+(a_{17})^{(2)}\mathbb{G}_{16}-(q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt}=-\left((a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)\mathbb{G}_{18}+(a_{18})^{(2)}\mathbb{G}_{17}-(q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt}=-\left((b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)\mathbb{T}_{16}+(b_{16})^{(2)}\mathbb{T}_{17}+\sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt}=-\left((b_{17}^{'})^{(2)}-(r_{17})^{(2)}\right)\mathbb{T}_{17}+(b_{17})^{(2)}\mathbb{T}_{16}+\sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt}=-\left((b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\mathbb{T}_{18}+(b_{18})^{(2)}\mathbb{T}_{17}+\sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad , T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*})=(q_{21})^{(3)} \quad , \frac{\partial(b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*})=s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt}=-\left((a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\mathbb{G}_{20}+(a_{20})^{(3)}\mathbb{G}_{21}-(q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt}=-\left((a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)\mathbb{G}_{21}+(a_{21})^{(3)}\mathbb{G}_{20}-(q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt}=-\left((a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)\mathbb{G}_{22}+(a_{22})^{(3)}\mathbb{G}_{21}-(q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt}=-\left((b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)\mathbb{T}_{20}+(b_{20})^{(3)}\mathbb{T}_{21}+\sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt}=-\left((b_{21}^{'})^{(3)}-(r_{21})^{(3)}\right)\mathbb{T}_{21}+(b_{21})^{(3)}\mathbb{T}_{20}+\sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt}=-\left((b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\mathbb{T}_{22}+(b_{22})^{(3)}\mathbb{T}_{21}+\sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}} (T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j} ((G_{27})^* \ ) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)} G_{24}^* \mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)} G_{25}^* \mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)} G_{26}^* \mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)} T_{24}^* \mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)} T_{25}^* \mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)} T_{26}^* \mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}} (T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j} ((G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)} G_{28}^* \mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)} G_{29}^* \mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)} G_{30}^* \mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)} T_{28}^* \mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)} T_{29}^* \mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)} T_{30}^* \mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}((G_{35})^*) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -((a_{32}^{'})^{(6)} + (p_{32})^{(6)})\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -((a_{33}^{'})^{(6)} + (p_{33})^{(6)})\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -((a_{34}^{'})^{(6)} + (p_{34})^{(6)})\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -((b_{32}^{'})^{(6)} - (r_{32})^{(6)})\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}(s_{(32)(j)}T_{32}^*\mathbb{G}_j)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -((b_{33}^{'})^{(6)} - (r_{33})^{(6)})\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}(s_{(33)(j)}T_{33}^*\mathbb{G}_j)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -((b_{34}^{'})^{(6)} - (r_{34})^{(6)})\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}(s_{(34)(j)}T_{34}^*\mathbb{G}_j)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}((G_{39})^{**}) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -((a_{36}^{'})^{(7)} + (p_{36})^{(7)})\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -((a_{37}^{'})^{(7)} + (p_{37})^{(7)})\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^{*}\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^{*}\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^{*}\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^{*}\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **<u>Theorem 8:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^{*}) = (q_{41})^{(8)} \quad , \frac{\partial (b_i^{''})^{(8)}}{\partial G_j}((G_{43})^{*}) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^{*}\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^{*}\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$ $$\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}} (T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i'')^{(9)}}{\partial G_j} ((G_{47})^*) = s_{ij}$$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)} G_{44}^* \mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)} G_{45}^* \mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)} G_{46}^* \mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)} T_{44}^* \mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)} T_{45}^* \mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)} T_{46}^* \mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)} G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)} T_{14}^* + (b_{14})^{(1)} s_{(13),(14)} T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}')^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)} G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)} G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)} T_{14}^* + (b_{14})^{(1)} s_{(13),(13)} T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)(q_{15})^{(1)} G_{15}$ $+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right) \left((a_{15})^{(1)}(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)} G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)} T_{14}^* + (b_{14})^{(1)} s_{(13),(15)} T_{13}^*\right)\} = 0$ +	

$$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}G_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$$

$$+\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)}\right)$$

$$\left[\left(\left((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$$

$$+\left(\left((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$$

$$+\left((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)}\right)$$

$$\left[\left(\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$$

$$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(6)}+(b'_{34})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a'_{34})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a'_{32})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G^*_{33}+(a_{33})^{(6)}(q_{32})^{(6)}G^*_{32}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T^*_{33}+(b_{33})^{(6)}s_{(32),(33)}T^*_{33}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a'_{33})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G^*_{32}+(a_{32})^{(6)}(q_{33})^{(6)}G^*_{33}\right)$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T^*_{33}+(b_{33})^{(6)}s_{(32),(32)}T^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2+\left((a'_{32})^{(6)}+(a'_{33})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2+\left((b'_{32})^{(6)}+(b'_{33})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2+\left((a'_{32})^{(6)}+(a'_{33})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a'_{32})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G^*_{33}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T^*_{33}+(b_{33})^{(6)}s_{(32),(34)}T^*_{32}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b'_{38})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a'_{38})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G^*_{37}+(a_{37})^{(7)}(q_{36})^{(7)}G^*_{36}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T^*_{37}+(b_{37})^{(7)}s_{(36),(37)}T^*_{37}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a'_{37})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G^*_{36}+(a_{36})^{(7)}(q_{37})^{(7)}G^*_{37}\right)$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T^*_{37}+(b_{37})^{(7)}s_{(36),(36)}T^*_{36}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2+\left((b'_{36})^{(7)}+(b'_{37})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G^*_{37}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G^*_{36}\right)$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T^*_{37}+(b_{37})^{(7)}s_{(36),(38)}T^*_{36}\right)\}=0$$

$+$

$((\lambda)^{(8)} + (b'_{42})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a'_{42})^{(8)} + (p_{42})^{(8)})$

$\left[\left(((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(q_{40})^{(8)}G^*_{40}\right)\right]$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T^*_{41} + (b_{41})^{(8)}s_{(40),(41)}T^*_{41}\right)$

$+\left(((\lambda)^{(8)} + (a'_{41})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G^*_{40} + (a_{40})^{(8)}(q_{41})^{(8)}G^*_{41}\right)$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T^*_{41} + (b_{41})^{(8)}s_{(40),(40)}T^*_{40}\right)$

$\left(((\lambda)^{(8)})^2 + ((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})(\lambda)^{(8)}\right)$

$\left(((\lambda)^{(8)})^2 + ((b'_{40})^{(8)} + (b'_{41})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)})(\lambda)^{(8)}\right)$

$+\left(((\lambda)^{(8)})^2 + ((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G^*_{40}\right)$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T^*_{41} + (b_{41})^{(8)}s_{(40),(42)}T^*_{40}\right)\} = 0$

$+$

$((\lambda)^{(9)} + (b'_{46})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a'_{46})^{(9)} + (p_{46})^{(9)})$

$\left[\left(((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(q_{44})^{(9)}G^*_{44}\right)\right]$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T^*_{45} + (b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$

$+\left(((\lambda)^{(9)} + (a'_{45})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G^*_{44} + (a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T^*_{45} + (b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$

$\left(((\lambda)^{(9)})^2 + ((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})(\lambda)^{(9)}\right)$

$\left(((\lambda)^{(9)})^2 + ((b'_{44})^{(9)} + (b'_{45})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)})(\lambda)^{(9)}\right)$

$+\left(((\lambda)^{(9)})^2 + ((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T^*_{45} + (b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\} = 0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.	

SECTION NINETEEN

Pseudo-Supersymmetric Quantum Mechanics

INTRODUCTION—VARIABLES USED

Pseudo-supersymmetric quantum mechanics and isospectral pseudo-Hermitian Hamiltonians Ali Mostafazadeh doi: 10.1016/S0550-3213(02)00347-4

(1) Authors examine the properties and consequences of (e) pseudo-supersymmetry for quantum systems admitting (eb) a pseudo-Hermitian Hamiltonian.
(2) Authors explore the Witten index of (e) pseudo-supersymmetry and show that (eb) every pair of (e) diagonalizable (not necessarily Hermitian) Hamiltonians with (e&eb) discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners.
(3) This implies (eb) that pseudo-supersymmetry is (=) the basic framework for generating (eb) non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯.
(4) In particular, this factorization applies to (e&eb) PT-symmetric and Hermitian Hamiltonians.
(5) The non-degenerate two-level systems provide (eb) a class of Hamiltonians that are (=) pseudo-Hermitian. They demonstrate the implications of general results for this class in some detail. Copyright © 2002 Elsevier Science B.V. All rights reserved.

Spectral equivalences, Bethe ansatz equations, and reality properties in Script PScript T-symmetric quantum mechanics Patrick Dorey1, Clare Dunning2 and Roberto Tateo1Published 6 July 2001 • Journal of Physics A: Mathematical and General, Volume 34, Number 28

(6) The one-dimensional Schrödinger equation for (e0 the potential x6 + αx2 + l(l + 1)/x2 has (e) many interesting properties.
(7) For certain values of the parameters l and α the equation are (=) in turn supersymmetric (Witten) and (e&eb) quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD.
(8) In this paper authors signal some further curious features of these theories, namely novel spectral equivalences with (e&eb, =) particular second- and third-order differential equations.
(9) These relationships are obtained via (e&eb) a recently observed connection between the theories of ordinary differential equations and (e&eb) integrable models.

(10) Generalized supersymmetry transformations acting at (e&eb) the quasi-exactly solvable points are also pointed out, and an efficient numerical procedure for (e) the study of these and related problems is described.

(11) Finally authors generalize slightly and then prove (eb) a conjecture due to Bessis, Zinn-Justin, Bender and Boettcher, concerning (e&eb) the reality of the spectra of certain Script PScript T-symmetric quantum mechanical systems.

Deformations of the spin currents by topological screw dislocation and cosmic dispiration Jian-Hua Wang, Kai Ma, Kang Li, Hua-wei Fan

(12) Authors study the spin currents induced by (e) topological screw dislocation and (e&eb) cosmic dispiration.

(13) By using the extended Drude model, authors find (eb) that the spin dependent forces are modified by (e&eb) the nontrivial geometry.

(14) For the topological screw dislocation, only the direction of spin current is bended by (e&eb) deforming the spin polarization vector.

(15) In contrast, the force induced by (e) cosmic dispiration could affect both (e&eb) the direction and magnitude of the spin current.

(16) As a consequence, the spin-Hall conductivity doesn't (e) receive corrections from screw dislocation. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); General Relativity and Quantum Cosmology (gr-qc); Quantum Physics (quant-ph) Journal reference:Ann. Phys. 362, 327(2015) DOI: 10.1016/j.aop.2015.08.004 Cite as: arXiv: 1510.07741 [cond-mat.mes-hall] (or arXiv:1510.07741v1 [cond-mat.mes-hall] for this version

NOTATION

Module One

Authors examine the properties and consequences of (e) pseudo-supersymmetry for quantum systems admitting (eb) a pseudo-Hermitian Hamiltonian

G_{13} : Category one of **properties and consequences;** pseudo-supersymmetry for quantum systems admitting (eb) a pseudo-Hermitian Hamiltonian

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of pseudo-supersymmetry for quantum systems admitting (eb) a pseudo-Hermitian Hamiltonian **;properties and consequences**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Authors examine the properties and consequences of pseudo-supersymmetry for quantum systems admitting (eb) a **pseudo-Hermitian Hamiltonian**

G_{16} : Category one of properties and consequences of pseudo-supersymmetry for quantum systems; **pseudo-Hermitian Hamiltonian**

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of **pseudo-Hermitian Hamiltonian** ;properties and consequences of pseudo-supersymmetry for quantum systems

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

Authors explore the Witten index of (e) pseudo-supersymmetry and show that (eb) every pair of (e) diagonalizable (not necessarily Hermitian) Hamiltonians with (e&eb) discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{20} : Category one of pseudo-supersymmetry

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of Witten index

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

Authors explore the Witten index of pseudo-supersymmetry and show that every pair of (e) diagonalizable (not necessarily Hermitian) Hamiltonians with (e&eb) discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{24} : Category one of Witten index of pseudo-supersymmetry and show that every pair; diagonalizable (not necessarily Hermitian) Hamiltonians with (e&eb) discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of diagonalizable (not necessarily Hermitian) Hamiltonians with (e&eb) discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners; Witten index of pseudo-supersymmetry and show that every pair

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

Authors explore the Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with (e&eb) discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{28} : Category one of **Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians;** discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners; **Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

Authors explore the Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of (e) eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{32} : Category one of eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

Authors explore the Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of eigenvalues are (=) isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{36} : Category one of Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of eigenvalues

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

Authors explore the Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of eigenvalues are isospectral and have (e) identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{40} : Category one of identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if (e) they are pseudo-supersymmetric partners

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of eigenvalues are isospectral

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

Authors explore the Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of eigenvalues are isospectral and have identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if they are pseudo-supersymmetric partners

G_{44} : Category one of Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of eigenvalues are isospectral and have identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if; they are pseudo-supersymmetric partners

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of they are pseudo-supersymmetric partners ;Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of eigenvalues are isospectral and have identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)} (T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)} (G, t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)} (G, t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)} (G, t) \right] T_{15}$	6
$+(a''_{13})^{(1)} (T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)} (G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)} (T_{17}, t) \right] G_{16}$	7

$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29

$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right]G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41},t)\right]G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45},t)\right]G_{45}$	50

$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{46}$	54
$+(a_{44}^{''})^{(9)} (T_{45}, t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)} \left((G_{47}), t \right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	*55*
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a_{14}^{'})^{(1)} \boxed{+(a_{14}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	*56*
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a_{15}^{'})^{(1)} \boxed{+(a_{15}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	*57*
Where $\boxed{(a_{13}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{14}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{15}^{''})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[\begin{matrix} (b_{13}^{'})^{(1)} \boxed{-(b_{13}^{''})^{(1)}(G,t)} \boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{36}^{''})^{(7,7,)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8)}(G_{43},t)} \boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	58

$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	60
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\ \boxed{-(b''_{13})^{(1,1,)}(G,t)}\ \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{16} \qquad 64$$

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\ \boxed{-(b''_{14})^{(1,1,)}(G,t)}\ \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{17} \qquad 65$$

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\ \boxed{-(b''_{15})^{(1,1,)}(G,t)}\ \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{18} \qquad 66$$

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$-(b_{36}'')^{(7,7,7)}(G_{39},t)$, $-(b_{37}'')^{(7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3

$-(b_{40}'')^{(8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8)}(G_{43},t)$, $-(b_{42}'')^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3

$-(b_{44}'')^{(9,9)}(G_{47},t)$, $-(b_{46}'')^{(9,9)}(G_{47},t)$, $-(b_{45}'')^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t) + (a_{16}'')^{(2,2,2)}(T_{17},t) + (a_{13}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{36}'')^{(7,7,7,7)}(T_{37},t) + (a_{40}'')^{(8,8,8,8)}(T_{41},t) + (a_{44}'')^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{20} \quad 67$$

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21},t) + (a_{17}'')^{(2,2,2)}(T_{17},t) + (a_{14}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{37}'')^{(7,7,7,7)}(T_{37},t) + (a_{41}'')^{(8,8,8,8)}(T_{41},t) + (a_{45}'')^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{21} \quad 68$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21},t) + (a_{18}'')^{(2,2,2)}(T_{17},t) + (a_{15}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{38}'')^{(7,7,7,7)}(T_{37},t) + (a_{42}'')^{(8,8,8,8)}(T_{41},t) + (a_{46}'')^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{22} \quad 69$$

$+(a_{20}'')^{(3)}(T_{21},t)$, $+(a_{21}'')^{(3)}(T_{21},t)$, $+(a_{22}'')^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3

$+(a_{16}'')^{(2,2,2)}(T_{17},t)$, $+(a_{17}'')^{(2,2,2)}(T_{17},t)$, $+(a_{18}'')^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3

$+(a_{13}'')^{(1,1,1,)}(T_{14},t)$, $+(a_{14}'')^{(1,1,1,)}(T_{14},t)$, $+(a_{15}'')^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3

$+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3

$+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3

$+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3

$+(a_{36}'')^{(7,7,7,7)}(T_{37},t)$, $+(a_{37}'')^{(7,7,7,7)}(T_{37},t)$, $+(a_{38}'')^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3

$+(a_{40}'')^{(8,8,8,8)}(T_{41},t)$, $+(a_{41}'')^{(8,8,8,8)}(T_{41},t)$, $+(a_{42}'')^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3

$+(a_{44}'')^{(9,9,9)}(T_{45},t)$, $+(a_{45}'')^{(9,9,9)}(T_{45},t)$, $+(a_{46}'')^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23},t) - (b_{16}'')^{(2,2,2)}(G_{19},t) - (b_{13}'')^{(1,1,1,)}(G,t) \\ -(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t) - (b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t) - (b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t) \\ - (b_{36}'')^{(7,7,7,7)}(G_{39},t) - (b_{40}'')^{(8,8,8,8)}(G_{43},t) - (b_{44}'')^{(9,9,9)}(G_{47},t) \end{matrix}\right] T_{20} \quad 70$$

$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21}$	71
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22}$	72

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24}$	73
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25}$	74
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$	75

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1,2\ \ 3$

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation*

coefficient for category 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$

are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$

are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$

are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$

are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$

are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28} \qquad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29} \qquad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30} \qquad 81$$

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28} \qquad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$$ 83

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$$ 84

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$$ 85

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$$ 86

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$$ 87

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34} \quad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1, 2, and 3

$-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2, and 3

$-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)$

are eighth detrition coefficients for category 1, 2, and 3

$-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 91$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14} \quad 92$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \quad 93$$

Where $(a''_{36})^{(7)}(T_{37},t)$, $(a''_{37})^{(7)}(T_{37},t)$, $(a''_{38})^{(7)}(T_{37},t)$ are first augmentation coefficients for category 1, 2 and 3

$+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3

$+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3

$+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for category 1, 2 and 3

$+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)$

are eighth augmentation coefficient for 1,2,3

$+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} -(b''_{36})^{(7)}(G_{39},t) & -(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t) & -(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t) & -(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t) & -(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{13})^{(1,1,1,1,1,1,1)}(G,t) & -(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t) & -(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} -(b''_{37})^{(7)}(G_{39},t) & -(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t) & -(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t) & -(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t) & -(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{14})^{(1,1,1,1,1,1,1)}(G,t) & -(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t) & -(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} -(b''_{38})^{(7)}(G_{39},t) & -(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t) & -(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t) & -(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t) & -(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{15})^{(1,1,1,1,1,1,1)}(G,t) & -(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t) & -(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{15}$	
Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3 $-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \begin{bmatrix} (a_{40}^{'})^{(8)} \boxed{+(a_{40}^{''})^{(8)}(T_{41},t)} \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \begin{bmatrix} (a_{41}^{'})^{(8)} \boxed{+(a_{41}^{''})^{(8)}(T_{41},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \begin{bmatrix} (a_{42}^{'})^{(8)} \boxed{+(a_{42}^{''})^{(8)}(T_{41},t)} \boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a_{40}^{''})^{(8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$\frac{dT_{40}}{dt} =$

$$(b_{40})^{(8)}T_{41}-\left[\begin{array}{lll}(b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{array}\right]T_{13}$$

$$\frac{dT_{41}}{dt}=$$

$$(b_{41})^{(8)}T_{40}-\left[\begin{array}{lll}(b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{array}\right]T_{14}$$

$$\frac{dT_{42}}{dt}=$$

$$(b_{42})^{(8)}T_{41}-\left[\begin{array}{lll}(b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{array}\right]T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt}=(a_{44})^{(9)}G_{45}-\left[\begin{array}{lll}(a'_{44})^{(9)}\boxed{+(a''_{44})^{(9)}(T_{45},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}\end{array}\right]G_{13}$$ 96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$(b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{46}}{dt} =$ $(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
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Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}', t)$ and $(a_i'')^{(2)}(T_{17}, t)$. (T_{17}', t) and (T_{17}, t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} \ , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
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$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i')^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	110
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$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
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They satisfy Lipschitz condition: $\|(a_i^{''})^{(3)}(T_{21}',t) - (a_i^{''})^{(3)}(T_{21},t)\| \le (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i^{''})^{(3)}(G_{23}',t) - (b_i^{''})^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
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Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
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$\lim_{G\to\infty}(b_i^{''})^{(4)}\left((G_{27}),t\right) = \ (r_i)^{(4)}$

Definition of $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$:

Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$

They satisfy Lipschitz condition: 119

$$|(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)| \le (\hat{k}_{24})^{(4)}|T_{25} - T_{25}^{'}|e^{-(\hat{M}_{24})^{(4)}t}$$

$$|(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}\left((G_{27}),t\right)| < (\hat{k}_{24})^{(4)}||(G_{27}) - (G_{27})^{'}||e^{-(\hat{M}_{24})^{(4)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: 120

$(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants

$$\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} \ , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$$

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: 121

There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}, i = 24,25,26$, satisfy the inequalities

$$\frac{1}{(\hat{M}_{24})^{(4)}}[\ (a_i)^{(4)} + (a_i^{'})^{(4)} + \ (\hat{A}_{24})^{(4)} + \ (\hat{P}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}] < 1$$

$$\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)} + (b_i^{'})^{(4)} + \ (\hat{B}_{24})^{(4)} + \ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}] < 1$$

Where we suppose

$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ 122

The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(5)},\ (r_i)^{(5)}$:

$$(a_i^{''})^{(5)}(T_{29},t) \le (p_i)^{(5)} \le (\hat{A}_{28})^{(5)}$$

$$(b_i^{''})^{(5)}\left((G_{31}),t\right) \le \ (r_i)^{(5)} \le (b_i^{'})^{(5)} \le (\hat{B}_{28})^{(5)}$$

$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t)=\ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and$(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $\big[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\big]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}',t)$ and$(a_i'')^{(6)}(T_{33},t)$. (T_{33}',t) and (T_{33},t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
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Where we suppose	
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Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (IIIII) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
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They satisfy Lipschitz condition:	
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}^{'}, t)$ and $(a_i^{''})^{(8)}(T_{41}, t)$. $(T_{41}^{'}, t)$ and (T_{41}, t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i^{''})^{(8)}(T_{41}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
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$(a_i)^{(9)}, (a_i^{'})^{(9)}, (a_i^{''})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (b_i^{''})^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$	146 A
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They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t) \rvert \leq (\hat{k}_{44})^{(9)} \lvert T_{45} - T_{45}^{'} \rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert (b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}((G_{47}),t) \rvert < (\hat{k}_{44})^{(9)} \lvert\lvert (G_{47}) - (G_{47})^{'} \rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $\left[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)} \right]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities	

$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i^{'})^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i^{'})^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t)\leq(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0)=G_i^0>0}$ $T_i(t)\leq(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0)=T_i^0>0}$	147
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Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t)\leq(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0)=G_i^0>0}$ $T_i(t)\leq(\hat{Q}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0)=T_i^0>0}$	151
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$G_i(t) \leq \left(\hat{P}_{32} \right)^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0) , T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
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$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{13}\left(s_{(13)}\right) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}\left(s_{(13)}\right) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{14}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)}\right) \right) G_{15}\left(s_{(13)}\right) \right] ds_{(13)}$	

$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
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Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{20}(s_{(20)}) \right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{22}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{20}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{\mathrm{T}}_{22}(\mathrm{t}) = \mathrm{T}_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{22}(s_{(20)}) \right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{\mathrm{T}}_{26}(\mathrm{t}) = \mathrm{T}_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{28} \,)^{(5)} \, , T_i^0 \leq (\, \hat{Q}_{28} \,)^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{28} \,)^{(5)} e^{(\, \hat{M}_{28} \,)^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{28} \,)^{(5)} e^{(\, \hat{M}_{28} \,)^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i \, , \, T_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} \, , T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	

$\overline{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{36})^{(7)}, T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\overline{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$,$T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a'_{44})^{(9)} + a''_{44})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a'_{45})^{(9)} + (a''_{45})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a'_{46})^{(9)} + (a''_{46})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{46}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b'_{44})^{(9)} - (b''_{44})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b'_{45})^{(9)} - (b''_{45})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b'_{46})^{(9)} - (b''_{46})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{46}(s_{(44)}) \right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	167

$G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0 \right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0} \right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14}, $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}} \right) \right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1 \right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0 \right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0} \right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for G_{17}, $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for G_{21}, $G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that	174

$$(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$$

(G_i^0) is as defined in the statement of theorem 4

The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that

$$G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)}\left(G_{29}^0+(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\right)\right]ds_{(28)} =$$

$$\left(1+(a_{28})^{(5)}t\right)G_{29}^0+\frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t}-1\right)$$

From which it follows that 175

$$(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{P}_{28})^{(5)}+G_{29}^0\right)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)}+(\hat{P}_{28})^{(5)}\right]$$

(G_i^0) is as defined in the statement of theorem 5

The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 176

$$G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)}\left(G_{33}^0+(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}s_{(32)}}\right)\right]ds_{(32)} =$$

$$\left(1+(a_{32})^{(6)}t\right)G_{33}^0+\frac{(a_{32})^{(6)}(\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left(e^{(\hat{M}_{32})^{(6)}t}-1\right)$$

From which it follows that 177

$$(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$$

(G_i^0) is as defined in the statement of theorem 6

Analogous inequalities hold also for G_{25} , G_{26}, T_{24}, T_{25}, T_{26}

(s) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 178

$$G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right]ds_{(36)} =$$

$$\left(1+(a_{36})^{(7)}t\right)G_{37}^0+\frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$$

From which it follows that

$$(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$$

(G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
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Definition of $\left((\widehat{M}_{16})^{(2)}\right)_1, \left((\widehat{M}_{16})^{(2)}\right)_2$ and $\left((\widehat{M}_{16})^{(2)}\right)_3$: 201

Remark 8: if G_{16} is bounded, the same property have also G_{17} and G_{18} . indeed if

$G_{16} < (\widehat{M}_{16})^{(2)}$ it follows $\frac{dG_{17}}{dt} \le \left((\widehat{M}_{16})^{(2)}\right)_1 - (a'_{17})^{(2)} G_{17}$ and by integrating

$G_{17} \le \left((\widehat{M}_{16})^{(2)}\right)_2 = G_{17}^0 + 2(a_{17})^{(2)}\left((\widehat{M}_{16})^{(2)}\right)_1/(a'_{17})^{(2)}$

In the same way , one can obtain

$G_{18} \le \left((\widehat{M}_{16})^{(2)}\right)_3 = G_{18}^0 + 2(a_{18})^{(2)}\left((\widehat{M}_{16})^{(2)}\right)_2/(a'_{18})^{(2)}$

If G_{17} or G_{18} is bounded, the same property follows for G_{16} , G_{18} and G_{16} , G_{17} respectively.

Remark 9: If G_{16} is bounded, from below, the same property holds for G_{17} and G_{18} . The proof is analogous with the preceding one. An analogous property is true if G_{17} is bounded from below. 202

Remark 10: If T_{16} is bounded from below and $\lim_{t\to\infty}((b''_i)^{(2)}((G_{19})(t),t)) = (b'_{17})^{(2)}$ then $T_{17} \to \infty$. 203

Definition of $(m)^{(2)}$ and ε_2 :

Indeed let t_2 be so that for $t > t_2$

$(b_{17})^{(2)} - (b''_i)^{(2)}((G_{19})(t),t) < \varepsilon_2, T_{16}(t) > (m)^{(2)}$

Then $\frac{dT_{17}}{dt} \ge (a_{17})^{(2)}(m)^{(2)} - \varepsilon_2 T_{17}$ which leads to 204

$T_{17} \ge \left(\frac{(a_{17})^{(2)}(m)^{(2)}}{\varepsilon_2}\right)(1 - e^{-\varepsilon_2 t}) + T_{17}^0 e^{-\varepsilon_2 t}$ If we take t such that $e^{-\varepsilon_2 t} = \frac{1}{2}$ it results

$T_{17} \ge \left(\frac{(a_{17})^{(2)}(m)^{(2)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_2}$ By taking now ε_2 sufficiently small one sees that T_{17} is unbounded. The same property holds for T_{18} if $\lim_{t\to\infty}(b''_{18})^{(2)}\left((G_{19})(t),t\right) = (b'_{18})^{(2)}$ 205

We now state a more precise theorem about the behaviors at infinity of the solutions of equations

It is now sufficient to take $\frac{(a_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}} < 1$ and to choose 207

$(\widehat{P}_{20})^{(3)}$ and $(\widehat{Q}_{20})^{(3)}$ large to have

$$\frac{(a_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}}\left[(\widehat{P}_{20})^{(3)} + \left((\widehat{P}_{20})^{(3)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{20})^{(3)} + G_j^0}{G_j^0}\right)}\right] \le (\widehat{P}_{20})^{(3)} \quad (208)$$

$$\frac{(b_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}}\left[\left((\widehat{Q}_{20})^{(3)} + T_j^0\right)e^{-\left(\frac{(\widehat{Q}_{20})^{(3)} + T_j^0}{T_j^0}\right)} + (\widehat{Q}_{20})^{(3)}\right] \le (\widehat{Q}_{20})^{(3)} \quad (209)$$

In order that the operator $\mathcal{A}^{(3)}$ transforms the space of sextuples of functions G_i, T_i satisfying 210

Equations into itself	
The operator $\mathcal{A}^{(3)}$ is a contraction with respect to the metric $d\left(\left((G_{23})^{(1)},(T_{23})^{(1)}\right),\left((G_{23})^{(2)},(T_{23})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\widehat{M}_{20})^{(3)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\widehat{M}_{20})^{(3)}t}\}$	211
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$T_i(t) \geq T_i^0 e^{(-(b_i')^{(3)}t)} > 0$ for t > 0	
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have 279 A

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$$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[\left((\widehat{Q}_{44})^{(9)} + T_j^0\right)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\widehat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

<u>Definition of</u> $\widetilde{(G_{47})}, \widetilde{(T_{47})} : \left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}), (T_{47})\right)$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t\{(a'_{44})^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)|\ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\widehat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

<u>Remark 41:</u> The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ and $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ and $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ and $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} and G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)}G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1/(a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2/(a_{46}^{'})^{(9)}$

If G_{45} or G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} is bounded, from below, the same property holds for G_{45} and G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right)$, $t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G, t) - (b_{14}^{''})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
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Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
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$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq$ $\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}] + G_{15}^0 e^{-(a_{15}')^{(1)}t})$	286
$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
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Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
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Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\big((G_{19}), t\big) - (b_{17}'')^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
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roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2+(\sigma_2)^{(2)}\nu^{(2)}-(a_{16})^{(2)}=0$	301
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$(m_2)^{(2)}=(\nu_0)^{(2)},(m_1)^{(2)}=(\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)}<(\nu_1)^{(2)}$	305
$(m_2)^{(2)}=(\nu_1)^{(2)},(m_1)^{(2)}=(\bar{\nu}_1)^{(2)},\boldsymbol{if}\ (\nu_1)^{(2)}<(\nu_0)^{(2)}<(\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)}=(\nu_1)^{(2)},(m_1)^{(2)}=(\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)}<(\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)}=(u_0)^{(2)},(\mu_1)^{(2)}=(u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)}<(u_1)^{(2)}$ $(\mu_2)^{(2)}=(u_1)^{(2)},(\mu_1)^{(2)}=(\bar{u}_1)^{(2)},\boldsymbol{if}\ (u_1)^{(2)}<(u_0)^{(2)}<(\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)}=\frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)}=(u_1)^{(2)},(\mu_1)^{(2)}=(u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)}<(u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t}\leq G_{16}(t)\leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}}G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t}\leq G_{17}(t)\leq\frac{1}{(m_2)^{(2)}}G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t}-e^{-(S_2)^{(2)}t}\right]+G_{18}^0 e^{-(S_2)^{(2)}t}\leq G_{18}(t)\leq\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t}-e^{-(a_{18}')^{(2)}t}\right]+G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t}\leq T_{16}(t)\leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}}T_{16}^0 e^{(R_1)^{(2)}t}\leq T_{16}(t)\leq\frac{1}{(\mu_2)^{(2)}}T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t}-e^{-(b_{18}')^{(2)}t}\right]+T_{18}^0 e^{-(b_{18}')^{(2)}t}\leq T_{18}(t)\leq$	315

$\frac{(a_{18})^{(2)}T^0_{16}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t}-e^{-(R_2)^{(2)}t}\right]+T^0_{18}e^{-(R_2)^{(2)}t}$	
Definition of $(S_1)^{(2)},(S_2)^{(2)},(R_1)^{(2)},(R_2)^{(2)}$:-	316
Where $(S_1)^{(2)}=(a_{16})^{(2)}(m_2)^{(2)}-(a'_{16})^{(2)}$ $(S_2)^{(2)}=(a_{18})^{(2)}-(p_{18})^{(2)}$	317
$(R_1)^{(2)}=(b_{16})^{(2)}(\mu_2)^{(1)}-(b'_{16})^{(2)}$ $(R_2)^{(2)}=(b'_{18})^{(2)}-(r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)}\le-(a'_{20})^{(3)}+(a'_{21})^{(3)}-(a''_{20})^{(3)}(T_{21},t)+(a''_{21})^{(3)}(T_{21},t)\le-(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)}\le-(b'_{20})^{(3)}+(b'_{21})^{(3)}-(b''_{20})^{(3)}(G_{23},t)-(b''_{21})^{(3)}((G_{23}),t)\le-(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)},(\nu_2)^{(3)},(u_1)^{(3)},(u_2)^{(3)}$: By $(\nu_1)^{(3)}>0,(\nu_2)^{(3)}<0$ and respectively $(u_1)^{(3)}>0,(u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2+(\sigma_1)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}(u^{(3)})^2+(\tau_1)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$ and By $(\bar{\nu}_1)^{(3)}>0,(\bar{\nu}_2)^{(3)}<0$ and respectively $(\bar{u}_1)^{(3)}>0,(\bar{u}_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2+(\sigma_2)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}(u^{(3)})^2+(\tau_2)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$	320
Definition of $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$ by $(m_2)^{(3)}=(\nu_0)^{(3)},(m_1)^{(3)}=(\nu_1)^{(3)},$ ***if*** $(\nu_0)^{(3)}<(\nu_1)^{(3)}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\bar{\nu}_1)^{(3)},$ ***if*** $(\nu_1)^{(3)}<(\nu_0)^{(3)}<(\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)}=\frac{G^0_{20}}{G^0_{21}}}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\nu_0)^{(3)},$ ***if*** $(\bar{\nu}_1)^{(3)}<(\nu_0)^{(3)}$	321

and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ , \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}\big((G_{27}),t\big) - (b_{25}'')^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)},\ \boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)},$ and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)},\ \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)},$ and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0, (\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0, (u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}(\nu^{(5)})^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}(u^{(5)})^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}(\nu^{(5)})^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}(u^{(5)})^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)},$ ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)},$	340

and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ ,\boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)} t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)} t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)} t}\right] + G_{30}^0 e^{-(S_2)^{(5)} t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b_{30}')^{(5)})}\left[e^{(R_1)^{(5)} t} - e^{-(b_{30}')^{(5)} t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)} t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)} t}\right] + T_{30}^0 e^{-(R_2)^{(5)} t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}((G_{35}), t) - (b''_{33})^{(6)}((G_{35}), t) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \ \boldsymbol{if} \ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \ \boldsymbol{if} \ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if} \ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
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Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the	362

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)},\ \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a'_{38})^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a'_{38})^{(7)}t}\right] + G_{38}^0 e^{-(a'_{38})^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b'_{38})^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b'_{38})^{(7)}t}\right] + T_{38}^0 e^{-(b'_{38})^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^{0}}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^{0}e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}^{'})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)}$ $(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} - (a_{40}^{''})^{(8)}(T_{41}, t) + (a_{41}^{''})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43}), t) - (b_{41}^{''})^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)} < (\nu_1)^{(8)}$	

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, $\boldsymbol{if}$ $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}$ $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)} t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)} t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)})} \left[e^{((S_1)^{(8)} - (p_{40})^{(8)})t} - e^{-(S_2)^{(8)} t} \right] + G_{42}^0 e^{-(S_2)^{(8)} t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)} - (a'_{42})^{(8)})} \left[e^{(S_1)^{(8)} t} - e^{-(a'_{42})^{(8)} t} \right] + G_{42}^0 e^{-(a'_{42})^{(8)} t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)} - (b'_{42})^{(8)})} \left[e^{(R_1)^{(8)} t} - e^{-(b'_{42})^{(8)} t} \right] + T_{42}^0 e^{-(b'_{42})^{(8)} t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)} + (r_{40})^{(8)} + (R_2)^{(8)})} \left[e^{((R_1)^{(8)} + (r_{40})^{(8)})t} - e^{-(R_2)^{(8)} t} \right] + T_{42}^0 e^{-(R_2)^{(8)} t}$	380
<u>Definition of</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \le -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \le -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \le -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \le -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}$, $\boldsymbol{if}$ $(\nu_0)^{(9)} < (\nu_1)^{(9)}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, $\boldsymbol{if}$ $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$, and $\boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$	
and analogously $(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, $\boldsymbol{if}$ $(u_0)^{(9)} < (u_1)^{(9)}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, $\boldsymbol{if}$ $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$, and $\boxed{(u_0)^{(9)} = \frac{T^0_{44}}{T^0_{45}}}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively	

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \le G_{44}(t) \le G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \le G_{45}(t) \le \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \le G_{46}(t) \le$$

$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t}\Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \le T_{44}(t) \le T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \le T_{44}(t) \le \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \le T_{46}(t) \le$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \le \frac{d\nu^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have <u>**Definition of**</u> $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain <u>**Definition of**</u> $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	386

Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
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From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}$, $\boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390
In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$	391
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If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393

If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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In a completely analogous way, we obtain **<u>Definition of</u>** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
<u>Particular case :</u> If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
<u>Definition of</u> $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$

Definition of $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$

$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
Proof : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **Definition of** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \le \frac{d\nu^{(4)}}{dt} \le -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \ge \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \le \nu^{(4)}(t) \le (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \le \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \le \nu^{(4)}(t) \le (\bar{\nu}_1)^{(4)}$	405
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \le \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \le \nu^{(4)}(t) \le$ $\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \le (\bar{\nu}_1)^{(4)} \le \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \le \nu^{(4)}(t) \le \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}^{''})^{(5)} = (a_{29}^{''})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}^{''})^{(5)} = (b_{29}^{''})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}^{'})^{(6)} - (a_{33}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33},t)\right) - (a_{33}^{''})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\ \nu^{(6)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\leq\ \nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$$(m_2)^{(6)}\leq\ \nu^{(6)}(t)\leq(m_1)^{(6)},\quad\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)}\leq\ u^{(6)}(t)\leq(\mu_1)^{(6)},\quad\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$**, and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \le \frac{d\nu^{(7)}}{dt} \le -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \ge \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \le \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \le \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \le \nu^{(7)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	424

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Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$,

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$

with $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system

Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations 426

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$ 427

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$ 428

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$, 429

$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

$with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - [(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - [(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - [(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\big((G_{27})\big)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\big((G_{27})\big)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\big((G_{27})\big)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\ ]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (s) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T_{14}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^* for which $f(T_{14}^*) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$	493
Definition and uniqueness of T_{17}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)} G_{17}}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)} G_{17}}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^{*})]}$	499
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*})=0$. With this value , we obtain from the three first equations $G_{40}=\frac{(a_{40})^{(8)}G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^{*})]}$, $G_{42}=\frac{(a_{42})^{(8)}G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*})=0$. With this value , we obtain from the three first equations $G_{44}=\frac{(a_{44})^{(9)}G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^{*})]}$, $G_{46}=\frac{(a_{46})^{(9)}G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G)=(b_{13}')^{(1)}(b_{14}')^{(1)}-(b_{13})^{(1)}(b_{14})^{(1)}-$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G)+(b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right]+(b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G)=0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*})=0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19})=(b_{16}')^{(2)}(b_{17}')^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19})+(b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right]+(b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19})=0$	503
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By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44},G_{45},G_{46}),G_{44},G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*)=0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*)=0$, T_{14}^* given by $f(T_{14}^*)=0$ and $G_{13}^*=\frac{(a_{13})^{(1)}G_{14}^*}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^*)]}$, $G_{15}^*=\frac{(a_{15})^{(1)}G_{14}^*}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^*)]}$ $T_{13}^*=\frac{(b_{13})^{(1)}T_{14}^*}{[(b_{13}^{'})^{(1)}-(b_{13}^{''})^{(1)}(G^*)]}$, $T_{15}^*=\frac{(b_{15})^{(1)}T_{14}^*}{[(b_{15}^{'})^{(1)}-(b_{15}^{''})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*)=0$, T_{17}^* given by $f(T_{17}^*)=0$ and	512
$G_{16}^*=\frac{(a_{16})^{(2)}G_{17}^*}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^*)]}$, $G_{18}^*=\frac{(a_{18})^{(2)}G_{17}^*}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^*)]}$	513
$T_{16}^*=\frac{(b_{16})^{(2)}T_{17}^*}{[(b_{16}^{'})^{(2)}-(b_{16}^{''})^{(2)}((G_{19})^*)]}$, $T_{18}^*=\frac{(b_{18})^{(2)}T_{17}^*}{[(b_{18}^{'})^{(2)}-(b_{18}^{''})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*)=0$, T_{21}^* given by $f(T_{21}^*)=0$ and $G_{20}^*=\frac{(a_{20})^{(3)}G_{21}^*}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^*)]}$, $G_{22}^*=\frac{(a_{22})^{(3)}G_{21}^*}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^*)]}$ $T_{20}^*=\frac{(b_{20})^{(3)}T_{21}^*}{[(b_{20}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23}{}^*)]}$, $T_{22}^*=\frac{(b_{22})^{(3)}T_{21}^*}{[(b_{22}^{'})^{(3)}-(b_{22}^{''})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^*=\frac{(a_{24})^{(4)}G_{25}^*}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^*=\frac{(a_{26})^{(4)}G_{25}^*}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^*=\frac{(b_{24})^{(4)}T_{25}^*}{[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^*=\frac{(b_{26})^{(4)}T_{25}^*}{[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b'_{28})^{(5)} - (b''_{28})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b'_{30})^{(5)} - (b''_{30})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b'_{32})^{(6)} - (b''_{32})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b'_{34})^{(6)} - (b''_{34})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b'_{36})^{(7)} - (b''_{36})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b'_{38})^{(7)} - (b''_{38})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b'_{40})^{(8)} - (b''_{40})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b'_{42})^{(8)} - (b''_{42})^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}^*)]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS __Theorem 4:__ If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote __Definition of__ $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}\left((G_{23})^*\right) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS __Theorem 4:__ If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
__Definition of__ $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}'')^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i'')^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}')^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}')^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}')^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}')^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}')^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}')^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(5)}$ *and* $(b_i'')^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}'')^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i'')^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\big((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\big)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\big((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\big)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\big((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\big)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\big((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\big)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\big(s_{(32)(j)}T_{32}^*\mathbb{G}_j\big)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\big((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\big)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\big(s_{(33)(j)}T_{33}^*\mathbb{G}_j\big)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\big((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\big)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\big(s_{(34)(j)}T_{34}^*\mathbb{G}_j\big)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\big((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\big)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\big((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\big)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^{*}\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^{*}\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^{*}\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^{*}\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** __**Theorem 8:**__ If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. __Proof:__ Denote	
__**Definition of**__ $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^{*}) = (q_{41})^{(8)} \quad , \frac{\partial(b_i^{''})^{(8)}}{\partial G_j}((G_{43})^{*}) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^{*}\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^{*}\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS __**Theorem 9:**__ If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{45})^{(9)}}{\partial T_{45}} (T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b''_i)^{(9)}}{\partial G_j} ((G_{47})^*) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a'_{44})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)} G_{44}^* \mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a'_{45})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)} G_{45}^* \mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a'_{46})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)} G_{46}^* \mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b'_{44})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)} T_{44}^* \mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b'_{45})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)} T_{45}^* \mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b'_{46})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)} T_{46}^* \mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b'_{15})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a'_{15})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)} G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)} T_{14}^* + (b_{14})^{(1)} s_{(13),(14)} T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a'_{14})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)} G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)} G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)} T_{14}^* + (b_{14})^{(1)} s_{(13),(13)} T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b'_{13})^{(1)} + (b'_{14})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$ $+\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right) \left((a_{15})^{(1)}(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)} G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)} T_{14}^* + (b_{14})^{(1)} s_{(13),(15)} T_{13}^*\right)\} = 0$ +	

$((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)})\{((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)})$

$\left[\left(((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)})(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)})s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)})(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)})s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(((\lambda)^{(2)})^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(((\lambda)^{(2)})^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(((\lambda)^{(2)})^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)})\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)})s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

+

$((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)})\{((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)})$

$\left[\left(((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)})(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)})s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)})(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$

$\left(((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)})s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$

$\left(((\lambda)^{(3)})^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$\left(((\lambda)^{(3)})^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$

$+\left(((\lambda)^{(3)})^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$

$+((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$

$\left(((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)})s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$

+

$((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(((\lambda)^{(4)})^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^{2}+\left((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(((\lambda)^{(5)})^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$ +	

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$\left((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)$

$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)$

$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(\left((\lambda)^{(9)}+(a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.	

SECTION TWENTY

Spectral Equivalences, Bethe Ansatz Equations, And Reality Properties

INTRODUCTION—VARIABLES USED

Pseudo-supersymmetric quantum mechanics and isospectral pseudo-Hermitian Hamiltonians Ali Mostafazadeh doi: 10.1016/S0550-3213(02)00347-4

(1) This implies (eb) that pseudo-supersymmetry is (=) the basic framework for generating (eb) non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯.

(2) In particular, this factorization applies to (e&eb) PT-symmetric and Hermitian Hamiltonians.

(3) The non-degenerate two-level systems provide (eb) a class of Hamiltonians that are (=) pseudo-Hermitian. They demonstrate the implications of general results for this class in some detail.

Spectral equivalences, Bethe ansatz equations, and reality properties in Script PScript T-symmetric quantum mechanics Patrick Dorey1, Clare Dunning2 and Roberto Tateo1Published 6 July 2001 • Journal of Physics A: Mathematical and General, Volume 34, Number 28

(4) The one-dimensional Schrödinger equation for (e0 the potential x6 + αx2 + l(l + 1)/x2 has (e) many interesting properties.

(5) For certain values of the parameters l and α the equation are (=) in turn supersymmetric (Witten) and (e&eb) quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD.

(6) In this paper authors signal some further curious features of these theories, namely novel spectral equivalences with (e&eb, =) particular second- and third-order differential equations.

(7) These relationships are obtained via (e&eb) a recently observed connection between the theories of ordinary differential equations and (e&eb) integrable models.

(8) Generalized supersymmetry transformations acting at (e&eb) the quasi-exactly solvable points are also pointed out, and an efficient numerical procedure for (e) the study of these and related problems is described.

(9) Finally authors generalize slightly and then prove (eb) a conjecture due to Bessis, Zinn-Justin, Bender and Boettcher, concerning (e&eb) the reality of the spectra of certain Script PScript T-symmetric quantum mechanical systems.

Deformations of the spin currents by topological screw dislocation and cosmic dispiration Jian-Hua Wang, Kai Ma, Kang Li, Hua-wei Fan

(10) Authors study the spin currents induced by (e) topological screw dislocation and (e&eb) cosmic dispiration.
(11) By using the extended Drude model, authors find (eb) that the spin dependent forces are modified by (e&eb) the nontrivial geometry.
(12) For the topological screw dislocation, only the direction of spin current is bended by (e&eb) deforming the spin polarization vector.
(13) In contrast, the force induced by (e) cosmic dispiration could affect both (e&eb) the direction and magnitude of the spin current.
(14) As a consequence, the spin-Hall conductivity doesn't (e) receive corrections from screw dislocation. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); General Relativity and Quantum Cosmology (gr-qc); Quantum Physics (quant-ph) Journal reference:Ann. Phys. 362, 327(2015) DOI: 10.1016/j.aop.2015.08.004 Cite as: arXiv: 1510.07741 [cond-mat.mes-hall] (or arXiv:1510.07741v1 [cond-mat.mes-hall] for this version

NOTATION

Module One

This implies (eb) that pseudo-supersymmetry is (=) the basic framework for generating (eb) non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{13} : Category one of Witten index of pseudo-supersymmetry and show that every pair of diagonalizable (not necessarily Hermitian) Hamiltonians with discrete spectra and real or complex-conjugate pairs of eigenvalues are isospectral and have identical degeneracy structure except perhaps for (e) the zero eigenvalue if and only if they are pseudo-supersymmetric partners

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of pseudo-supersymmetry is (=) the basic framework for generating (eb) non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

This implies (eb) that pseudo-supersymmetry is (=) the basic framework for generating (eb) non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{16} : Category one of pseudo-supersymmetry

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of basic framework for generating (eb) non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

This implies that pseudo-supersymmetry is the basic framework for generating (eb) non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{20} : Category one of pseudo-supersymmetry is the basic framework

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

This implies that pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and (e&eb) non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{24} : Category one of **pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric;** non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯; **pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

This implies that pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with (e&eb) a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{28} : Category one of **pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians;** real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯; **pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

This implies that pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum via (e&eb) a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{32} : Category one of **pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum;** Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯;**pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum**

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

This implies that pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum via a Darboux transformation, and shows (eb) that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{36} : Category one of pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum via a Darboux transformation

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

This implies that pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum via a Darboux transformation, and shows that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be (=) factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{40} : Category one of pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum via a Darboux transformation, and shows that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

This implies that pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum via a Darboux transformation, and shows that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be factored as H=L♯L where (e) L is a linear operator with pseudo-adjoint L♯

G_{44} : Category one of L is a linear operator with pseudo-adjoint L♯

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of pseudo-supersymmetry is the basic framework for generating non-Hermitian PT-symmetric and non-PT-symmetric Hamiltonians with a real spectrum via a Darboux transformation, and shows that every diagonalizable Hamiltonian H with a discrete spectrum and real or complex-conjugate pairs of eigenvalues may be factored as H=L♯L

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$,	

$(a_{40}^{'})^{(8)}, (a_{41}^{'})^{(8)}, (a_{42}^{'})^{(8)}, (b_{40}^{'})^{(8)}, (b_{41}^{'})^{(8)}, (b_{42}^{'})^{(8)}$, $(a_{44}^{'})^{(9)}, (a_{45}^{'})^{(9)}, (a_{46}^{'})^{(9)}, (b_{44}^{'})^{(9)}, (b_{45}^{'})^{(9)}, (b_{46}^{'})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four	

The differential system of this model is now (Module numbered Four)	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t)\right]G_{38}$	*39*

$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}')^{(7)} - (b_{36}'')^{(7)}\left((G_{39}),t\right)\right] T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}')^{(7)} - (b_{37}'')^{(7)}\left((G_{39}),t\right)\right] T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}')^{(7)} - (b_{38}'')^{(7)}\left((G_{39}),t\right)\right] T_{38}$	42
$+(a_{36}'')^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}')^{(8)} + (a_{41}'')^{(8)}(T_{41},t)\right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41},t)\right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}')^{(8)} - (b_{40}'')^{(8)}\left((G_{43}),t\right)\right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}')^{(8)} - (b_{41}'')^{(8)}\left((G_{43}),t\right)\right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}')^{(8)} - (b_{42}'')^{(8)}\left((G_{43}),t\right)\right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45},t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45},t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45},t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}')^{(9)} - (b_{44}'')^{(9)}\left((G_{47}),t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}')^{(9)} - (b_{45}'')^{(9)}\left((G_{47}),t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}')^{(9)} - (b_{46}'')^{(9)}\left((G_{47}),t\right)\right] T_{46}$	54
$+(a_{44}'')^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b_{44}'')^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \begin{bmatrix} (a_{13}')^{(1)} \boxed{+(a_{13}'')^{(1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a_{14}')^{(1)} \boxed{+(a_{14}'')^{(1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{37}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a_{15}')^{(1)} \boxed{+(a_{15}'')^{(1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a_{13}'')^{(1)}(T_{14},t)}$, $\boxed{(a_{14}'')^{(1)}(T_{14},t)}$, $\boxed{(a_{15}'')^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}'')^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for	

category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3	

$-(b''_{40})^{(8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} +(a''_{16})^{(2)}(T_{17},t) +(a''_{13})^{(1,1,)}(T_{14},t) +(a''_{20})^{(3,3,3)}(T_{21},t) \\ +(a''_{24})^{(4,4,4,4,4)}(T_{25},t) +(a''_{28})^{(5,5,5,5,5)}(T_{29},t) +(a''_{32})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{36})^{(7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8)}(T_{41},t) +(a''_{44})^{(9,9)}(T_{45},t) \end{matrix} \right] G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} +(a''_{17})^{(2)}(T_{17},t) +(a''_{14})^{(1,1,)}(T_{14},t) +(a''_{21})^{(3,3,3)}(T_{21},t) \\ +(a''_{25})^{(4,4,4,4,4)}(T_{25},t) +(a''_{29})^{(5,5,5,5,5)}(T_{29},t) +(a''_{33})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{37})^{(7,7,7)}(T_{37},t) +(a''_{41})^{(8,8,8)}(T_{41},t) +(a''_{45})^{(9,9)}(T_{45},t) \end{matrix} \right] G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} +(a''_{18})^{(2)}(T_{17},t) +(a''_{15})^{(1,1,)}(T_{14},t) +(a''_{22})^{(3,3,3)}(T_{21},t) \\ +(a''_{26})^{(4,4,4,4,4)}(T_{25},t) +(a''_{30})^{(5,5,5,5,5)}(T_{29},t) +(a''_{34})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{38})^{(7,7,7)}(T_{37},t) +(a''_{42})^{(8,8,8)}(T_{41},t) +(a''_{46})^{(9,9)}(T_{45},t) \end{matrix} \right] G_{18}$	63
Where $+(a''_{16})^{(2)}(T_{17},t)$, $+(a''_{17})^{(2)}(T_{17},t)$, $+(a''_{18})^{(2)}(T_{17},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,)}(T_{14},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3 $+(a''_{44})^{(9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9)}(T_{45},t)$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} -(b''_{16})^{(2)}(G_{19},t) -(b''_{13})^{(1,1,)}(G,t) -(b''_{20})^{(3,3,3,)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8)}(G_{43},t) -(b''_{44})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{16}$	64

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17}$$ 65

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18}$$ 66

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{20}$$ 67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21}$$ 68

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22}$$ 69

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)}\boxed{-(b''_{20})^{(3)}(G_{23},t)}\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)}\boxed{-(b''_{21})^{(3)}(G_{23},t)}\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)}\boxed{-(b''_{22})^{(3)}(G_{23},t)}\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$ $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$(a''_{24})^{(4)}(T_{25},t)$, $(a''_{25})^{(4)}(T_{25},t)$, $(a''_{26})^{(4)}(T_{25},t)$ *are first augmentation coefficients category* 1, 2 3

$+(a''_{28})^{(5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3

$+(a''_{32})^{(6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3

$+(a''_{13})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1)}(T_{14},t)$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{16})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2)}(T_{17},t)$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{20})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3)}(T_{21},t)$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{46})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9)}(T_{45},t)$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[\begin{matrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{25}$	77
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[\begin{matrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{26}$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation*	

$coefficient\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation$
$coefficient\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28} \quad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30} \quad 84$$

$where$ $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ $are\ first\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ $are\ second\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ $are\ third\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition

coefficients for category 1,2, and 3

$-(b_{42}'')^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b_{40}'')^{(8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1,2, and 3

$-(b_{46}'')^{(9,9,9,9,9)}(G_{47},t)$, $-(b_{45}'')^{(9,9,9,9,9)}(G_{47},t)$, $-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[\begin{matrix}(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33},t)+(a_{28}'')^{(5,5,5)}(T_{29},t)+(a_{24}'')^{(4,4,4,)}(T_{25},t)\\+(a_{13}'')^{(1,1,1,1,1,1)}(T_{14},t)+(a_{16}'')^{(2,2,2,2,2,2)}(T_{17},t)+(a_{20}'')^{(3,3,3,3,3,3)}(T_{21},t)\\+(a_{36}'')^{(7,7,7,7,7,7,7)}(T_{37},t)+(a_{40}'')^{(8,8,8,8,8,8,8)}(T_{41},t)+(a_{44}'')^{(9,9,9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{32} \quad 85$$

$$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\left[\begin{matrix}(a_{33}')^{(6)}+(a_{33}'')^{(6)}(T_{33},t)+(a_{29}'')^{(5,5,5)}(T_{29},t)+(a_{25}'')^{(4,4,4,)}(T_{25},t)\\+(a_{14}'')^{(1,1,1,1,1,1)}(T_{14},t)+(a_{17}'')^{(2,2,2,2,2,2)}(T_{17},t)+(a_{21}'')^{(3,3,3,3,3,3)}(T_{21},t)\\+(a_{37}'')^{(7,7,7,7,7,7,7)}(T_{37},t)+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)+(a_{45}'')^{(9,9,9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{33} \quad 86$$

$$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\left[\begin{matrix}(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33},t)+(a_{30}'')^{(5,5,5)}(T_{29},t)+(a_{26}'')^{(4,4,4,)}(T_{25},t)\\+(a_{15}'')^{(1,1,1,1,1,1)}(T_{14},t)+(a_{18}'')^{(2,2,2,2,2,2)}(T_{17},t)+(a_{22}'')^{(3,3,3,3,3,3)}(T_{21},t)\\+(a_{38}'')^{(7,7,7,7,7,7,7)}(T_{37},t)+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)+(a_{46}'')^{(9,9,9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{34} \quad 87$$

$+(a_{32}'')^{(6)}(T_{33},t)$, $+(a_{33}'')^{(6)}(T_{33},t)$, $+(a_{34}'')^{(6)}(T_{33},t)$ *are first augmentation coefficients for category* 1, 2 *and* 3

$+(a_{28}'')^{(5,5,5)}(T_{29},t)$, $+(a_{29}'')^{(5,5,5)}(T_{29},t)$, $+(a_{30}'')^{(5,5,5)}(T_{29},t)$ *are second augmentation coefficients for category* 1, 2 *and* 3

$+(a_{24}'')^{(4,4,4,)}(T_{25},t)$, $+(a_{25}'')^{(4,4,4,)}(T_{25},t)$, $+(a_{26}'')^{(4,4,4,)}(T_{25},t)$ *are third augmentation coefficients for category* 1, 2 *and* 3

$+(a_{13}'')^{(1,1,1,1,1,1)}(T_{14},t)$, $+(a_{14}'')^{(1,1,1,1,1,1)}(T_{14},t)$, $+(a_{15}'')^{(1,1,1,1,1,1)}(T_{14},t)$ - are fourth augmentation coefficients

$+(a_{16}'')^{(2,2,2,2,2,2)}(T_{17},t)$, $+(a_{17}'')^{(2,2,2,2,2,2)}(T_{17},t)$, $+(a_{18}'')^{(2,2,2,2,2,2)}(T_{17},t)$ - fifth augmentation coefficients

$+(a_{20}'')^{(3,3,3,3,3,3)}(T_{21},t)$, $+(a_{21}'')^{(3,3,3,3,3,3)}(T_{21},t)$, $+(a_{22}'')^{(3,3,3,3,3,3)}(T_{21},t)$ sixth augmentation coefficients

$+(a_{36}'')^{(7,7,7,7,7,7,7)}(T_{37},t)$, $+(a_{37}'')^{(7,7,7,7,7,7,7)}(T_{37},t)$, $+(a_{38}'')^{(7,7,7,7,7,7,7)}(T_{37},t)$ seventh augmentation coefficients

$+(a_{40}'')^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)$ Eighth augmentation coefficients

$+(a_{44}'')^{(9,9,9,9,9,9)}(T_{45},t)$, $+(a_{45}'')^{(9,9,9,9,9,9)}(T_{45},t)$, $+(a_{46}'')^{(9,9,9,9,9,9)}(T_{45},t)$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\left[\begin{matrix}(b_{32}')^{(6)}-(b_{32}'')^{(6)}(G_{35},t)-(b_{28}'')^{(5,5,5)}(G_{31},t)-(b_{24}'')^{(4,4,4,)}(G_{27},t)\\-(b_{13}'')^{(1,1,1,1,1,1)}(G,t)-(b_{16}'')^{(2,2,2,2,2,2)}(G_{19},t)-(b_{20}'')^{(3,3,3,3,3,3)}(G_{23},t)\\-(b_{36}'')^{(7,7,7,7,7,7,7)}(G_{39},t)-(b_{40}'')^{(8,8,8,8,8,8,8)}(G_{43},t)-(b_{44}'')^{(9,9,9,9,9,9)}(G_{47},t)\end{matrix}\right]T_{32} \quad 88$$

$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$	*89*
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$	*90*
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*91*
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	*92*

$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	93
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	*95*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second	

augmentation coefficient for category 1, 2 and 3

$+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3

$+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ $+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ $+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for 1,2,3

$+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$ are eighth augmentation coefficient for 1,2,3

$+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3

$-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3

$-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3

$-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \right] G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b'_{44})^{(9)}\boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b'_{45})^{(9)}\boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)}\boxed{-(b''_{46})^{(9)}(G_{47},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

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They satisfy Lipschitz condition:	

$$|(a_i^{''})^{(9)}(T_{45}^{'},t)-(a_i^{''})^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45}-T_{45}^{'}|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i^{''})^{(9)}((G_{47})^{'},t)-(b_i^{''})^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47})-(G_{47})^{'}||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i^{'})^{(9)},(b_i)^{(9)},(b_i^{'})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}, i=44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i^{'})^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i^{'})^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t} , \quad \boxed{G_i(0)=G_i^0>0}$$

$$T_i(t) \leq (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t} , \quad \boxed{T_i(0)=T_i^0>0}$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0), T_i(0)$

$$G_i(t) \leq (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t} , \quad G_i(0)=G_i^0>0$$

$$T_i(t) \leq (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t} , \quad T_i(0)=T_i^0>0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t) \leq (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t} , \quad G_i(0)=G_i^0>0$$

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$T_i(t) \leq \left(\hat{Q}_{20} \right)^{(3)} e^{\left(\hat{M}_{20} \right)^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24} \right)^{(4)} e^{\left(\hat{M}_{24} \right)^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{24} \right)^{(4)} e^{\left(\hat{M}_{24} \right)^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
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$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{16}(s_{(16)}) \right] ds_{(16)}$	160
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$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
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$0 \le G_i(t) - G_i^0 \le (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
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$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \le (\hat{P}_{24})^{(4)}$, $T_i^0 \le (\hat{Q}_{24})^{(4)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)}\ ,T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \leq (\ \hat{P}_{36}\ )^{(7)}\ ,T_i^0 \leq (\ \hat{Q}_{36}\ )^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{36}\ )^{(7)} e^{(\ \hat{M}_{36}\ )^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{36}\ )^{(7)} e^{(\ \hat{M}_{36}\ )^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}')^{(9)} + a_{44}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}')^{(9)} - (b_{44}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}')^{(9)} - (b_{45}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}')^{(9)} - (b_{46}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \le G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \le \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14}, $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \le G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \le \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17}, $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0) e^{-(\hat{M}_{24})^{(4)} t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left[\left((\hat{P}_{24})^{(4)} + G_{25}^0 \right) e^{\left(-\frac{(\hat{P}_{24})^{(4)} + G_{25}^0}{G_{25}^0} \right)} + (\hat{P}_{24})^{(4)} \right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176

From which it follows that $(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(t) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0+\int_0^t\left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right]ds_{(36)}=$ $\left(1+(a_{36})^{(7)}t\right)G_{37}^0+\frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$	178
From which it follows that $(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0+\int_0^t\left[(a_{40})^{(8)}\left(G_{41}^0+(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right]ds_{(40)}=$ $\left(1+(a_{40})^{(8)}t\right)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	180
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Definition of $\left((\widehat{M}_{36})^{(7)}\right)_1,\left((\widehat{M}_{36})^{(7)}\right)_2$ *and* $\left((\widehat{M}_{36})^{(7)}\right)_3$: **Remark 33:** if G_{36} is bounded, the same property have also G_{37} *and* G_{38} . indeed if $G_{36}<(\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt}\le\left((\widehat{M}_{36})^{(7)}\right)_1-(a'_{37})^{(7)}G_{37}$ and by integrating $G_{37}\le\left((\widehat{M}_{36})^{(7)}\right)_2=G_{37}^0+2(a_{37})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_1/(a'_{37})^{(7)}$ In the same way , one can obtain $G_{38}\le\left((\widehat{M}_{36})^{(7)}\right)_3=G_{38}^0+2(a_{38})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_2/(a'_{38})^{(7)}$ If G_{37} *or* G_{38} is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.	262
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Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(7)}((G_{39})(t),t)) = (b_{37}^{'})^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i^{''})^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$	264
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$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{Q}_{40})^{(8)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{40})^{(8)}\right] \leq (\hat{Q}_{40})^{(8)}$	268
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\|G_i^{(1)}(t) - G_i^{(2)}(t)\|e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+}\|T_i^{(1)}(t) - T_i^{(2)}(t)\|e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **Definition of** $\widetilde{(G_{43})}, \widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
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Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,t]$ From the hypotheses it follows	272
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<u>Remark 37</u> There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(8)} - (a''_i)^{(8)}(T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b'_i)^{(8)} t)} > 0$ for $t > 0$	275
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If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\big(\widetilde{(G_{47})}, \widetilde{(T_{47})}\big) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \le \int_0^t (a_{44})^{(9)} \left|G_{45}^{(1)} - G_{45}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$
$\int_0^t \{(a'_{44})^{(9)} \left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)} |(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}}\} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} t} \le$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right) d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \ge G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(9)} - (a''_i)^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \ge 0$$

$$T_i(t) \ge T_i^0 e^{\left(-(b'_i)^{(9)} t\right)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \le \left((\widehat{M}_{44})^{(9)}\right)_1 - (a'_{45})^{(9)} G_{45}$ and by integrating

$$G_{45} \le \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a'_{45})^{(9)}$$

In the same way , one can obtain

$$G_{46} \le \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a'_{46})^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t),t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t),t) = (b_{46}^{'})^{(9)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying

$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14},t) + (a_{14}^{''})^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$

Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: 281

By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: 282

By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- 283

If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by

$(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \; if \; (\nu_0)^{(1)} < (\nu_1)^{(1)}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \; (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$

and $(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}\ , if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
<u>Definition of</u> $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
<u>Behavior of the solutions of equation</u>	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \le -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \le -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \le -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}), t\right) - (b_{17}^{''})^{(2)}\left((G_{19}), t\right) \le -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}$, $\boldsymbol{if}$ $(\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}$, $\boldsymbol{if}$ $(\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}$, $\boldsymbol{if}$ $(u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}$, $\boldsymbol{if}$ $(u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{16}(t) \le G_{16}^0 e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{17}(t) \le \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \le G_{18}(t) \le$ $\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}] + G_{18}^0 e^{-(a_{18}')^{(2)}t})$	312
$T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \le T_{18}(t) \le$ $\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \le -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \le -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \le -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}\big((G_{23}), t\big) \le -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0$, $(\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0$, $(u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0\,, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0\,, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},\ \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},\ \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq \right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)},(S_2)^{(3)},(R_1)^{(3)},(R_2)^{(3)}$:- Where $(S_1)^{(3)}=(a_{20})^{(3)}(m_2)^{(3)}-(a_{20}^{'})^{(3)}$ $(S_2)^{(3)}=(a_{22})^{(3)}-(p_{22})^{(3)}$ $(R_1)^{(3)}=(b_{20})^{(3)}(\mu_2)^{(3)}-(b_{20}^{'})^{(3)}$ $(R_2)^{(3)}=(b_{22}^{'})^{(3)}-(r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)},(\sigma_2)^{(4)},(\tau_1)^{(4)},(\tau_2)^{(4)}$: $(\sigma_1)^{(4)},(\sigma_2)^{(4)},(\tau_1)^{(4)},(\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)}\le-(a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}-(a_{24}^{''})^{(4)}(T_{25},t)+(a_{25}^{''})^{(4)}(T_{25},t)\le-(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)}\le-(b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(b_{24}^{''})^{(4)}\big((G_{27}),t\big)-(b_{25}^{''})^{(4)}\big((G_{27}),t\big)\le-(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)},(\nu_2)^{(4)},(u_1)^{(4)},(u_2)^{(4)},\nu^{(4)},u^{(4)}$: By $(\nu_1)^{(4)}>0,(\nu_2)^{(4)}<0$ and respectively $(u_1)^{(4)}>0,(u_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2+(\sigma_1)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},,(\bar{\nu}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)}>0,(\bar{\nu}_2)^{(4)}<0$ and respectively $(\bar{u}_1)^{(4)}>0,(\bar{u}_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2+(\sigma_2)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(\nu_0)^{(4)},(m_1)^{(4)}=(\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)}<(\nu_1)^{(4)}$ $(m_2)^{(4)}=(\nu_1)^{(4)},(m_1)^{(4)}=(\bar{\nu}_1)^{(4)},\boldsymbol{if}\ (\nu_4)^{(4)}<(\nu_0)^{(4)}<(\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(\nu_4)^{(4)},(m_1)^{(4)}=(\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)}<(\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar{u}_1)^{(4)},\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar{u}_1)^{(4)}$,	331

and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>**Definition of**</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>**Definition of**</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)}$, , $(\bar{\nu}_2)^{(5)}$, $(\bar{u}_1)^{(5)}$, $(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}$, $(\mu_2)^{(5)}$, $(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}$, $(\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}, \ \boldsymbol{if} \ (\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)} , \boldsymbol{if} \ (\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}, \ \boldsymbol{if} \ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)} , \boldsymbol{if} \ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if} \ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b_{30}')^{(5)}t}\right]+T_{30}^0e^{-(b_{30}')^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)},(S_2)^{(5)},(R_1)^{(5)},(R_2)^{(5)}$:- Where $(S_1)^{(5)}=(a_{28})^{(5)}(m_2)^{(5)}-(a_{28}')^{(5)}$ $(S_2)^{(5)}=(a_{30})^{(5)}-(p_{30})^{(5)}$ $(R_1)^{(5)}=(b_{28})^{(5)}(\mu_2)^{(5)}-(b_{28}')^{(5)}$ $(R_2)^{(5)}=(b_{30}')^{(5)}-(r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$: $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)}\leq-(a_{32}')^{(6)}+(a_{33}')^{(6)}-(a_{32}'')^{(6)}(T_{33},t)+(a_{33}'')^{(6)}(T_{33},t)\leq-(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)}\leq-(b_{32}')^{(6)}+(b_{33}')^{(6)}-(b_{32}'')^{(6)}((G_{35}),t)-(b_{33}'')^{(6)}((G_{35}),t)\leq-(\tau_1)^{(6)}$	349
Definition of $(\nu_1)^{(6)},(\nu_2)^{(6)},(u_1)^{(6)},(u_2)^{(6)},\nu^{(6)},u^{(6)}$: By $(\nu_1)^{(6)}>0,(\nu_2)^{(6)}<0$ and respectively $(u_1)^{(6)}>0,(u_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}(u^{(6)})^2+(\tau_1)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}(u^{(6)})^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},\boldsymbol{if}\ (\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
<u>**Definition of**</u> $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \; \boldsymbol{if} \; (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if} \; (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \; \boldsymbol{if} \; (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if} \; (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if} \; (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)} t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}')^{(7)}$ $(R_2)^{(7)} = (b_{38}')^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}')^{(8)} + (a_{41}')^{(8)} - (a_{40}'')^{(8)}(T_{41}, t) + (a_{41}'')^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}')^{(8)} + (b_{41}')^{(8)} - (b_{40}'')^{(8)}((G_{43}), t) - (b_{41}'')^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}(\nu^{(8)})^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}, \ \boldsymbol{if} \ (\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}, \boldsymbol{if} \ (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}, \ \boldsymbol{if} \ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}, \boldsymbol{if} \ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if} \ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)}T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)}T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a_{44}')^{(9)} + (a_{45}')^{(9)} - (a_{44}'')^{(9)}(T_{45}, t) + (a_{45}'')^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b_{44}')^{(9)} + (b_{45}')^{(9)} - (b_{44}'')^{(9)}((G_{47}), t) - (b_{45}'')^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}$, ***if*** $(\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, $\boldsymbol{if}$ $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$, and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$	
and analogously $(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, $\boldsymbol{if}$ $(u_0)^{(9)} < (u_1)^{(9)}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, $\boldsymbol{if}$ $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$, and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively	
Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	
($\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$ $\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t}$)	
$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$ $\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
<u>Definition of</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$	

$$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \le \frac{d\nu^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \ge \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \le \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \le \nu^{(1)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \le (\bar{\nu}_1)^{(1)} \le \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \le \nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have **<u>Definition of</u>** $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **<u>Definition of</u>** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. <u>Particular case :</u> If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
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From which one obtains **<u>Definition of</u>** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)},\quad\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)},\quad\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$ if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

<u>Proof</u> : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

<u>Definition of</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

<u>Definition of</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$**.**

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$ if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ *with* $(p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (t) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) +$	492 A

$(a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45})=0$	
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*})=0$. With this value , we obtain from the three first equations $G_{13}=\frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^{*})]}$, $G_{15}=\frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*})=0$. With this value , we obtain from the three first equations	494
$G_{16}=\frac{(a_{16})^{(2)}G_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^{*})]}$, $G_{18}=\frac{(a_{18})^{(2)}G_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a''_i)^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*})=0$. With this value , we obtain from the three first equations $G_{20}=\frac{(a_{20})^{(3)}G_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^{*})]}$, $G_{22}=\frac{(a_{22})^{(3)}G_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a''_i)^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*})=0$. With this value , we obtain from the three first equations $G_{24}=\frac{(a_{24})^{(4)}G_{25}}{[(a'_{24})^{(4)}+(a''_{24})^{(4)}(T_{25}^{*})]}$, $G_{26}=\frac{(a_{26})^{(4)}G_{25}}{[(a'_{26})^{(4)}+(a''_{26})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a''_i)^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*})=0$. With this value , we obtain from the three first equations $G_{28}=\frac{(a_{28})^{(5)}G_{29}}{[(a'_{28})^{(5)}+(a''_{28})^{(5)}(T_{29}^{*})]}$, $G_{30}=\frac{(a_{30})^{(5)}G_{29}}{[(a'_{30})^{(5)}+(a''_{30})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a''_i)^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*})=0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T^*_{33})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T^*_{33})]}$	
Definition and uniqueness of T^*_{37} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T^*_{37} for which $f(T^*_{37}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T^*_{37})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T^*_{37})]}$	500
Definition and uniqueness of T^*_{41} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T^*_{41} for which $f(T^*_{41}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T^*_{41})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T^*_{41})]}$	501
Definition and uniqueness of T^*_{45} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T^*_{45} for which $f(T^*_{45}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T^*_{45})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T^*_{45})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b'_{13})^{(1)}(b''_{14})^{(1)}(G) + (b'_{14})^{(1)}(b''_{13})^{(1)}(G)\right] + (b''_{13})^{(1)}(G)(b''_{14})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{14} such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b'_{16})^{(2)}(b''_{17})^{(2)}(G_{19}) + (b'_{17})^{(2)}(b''_{16})^{(2)}(G_{19})\right] + (b''_{16})^{(2)}(G_{19})(b''_{17})^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18})$, G_{16}, G_{18} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right] + (b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22})$, G_{20}, G_{22} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27}) + (b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right] + (b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26})$, G_{24}, G_{26} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*}) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31}) + (b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right] + (b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30})$, G_{28}, G_{30} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*}) = 0$	507
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By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39}) + (b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right] + (b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38})$, G_{36}, G_{38} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*}) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
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Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b'_{16})^{(2)} - (b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b'_{18})^{(2)} - (b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^{*} given by $\varphi(G_{27}) = 0$, T_{25}^{*} given by $f(T_{25}^{*}) = 0$ and $G_{24}^{*} = \frac{(a_{24})^{(4)} G_{25}^{*}}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26}^{*} = \frac{(a_{26})^{(4)} G_{25}^{*}}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^{*})]}$	516
$T_{24}^{*} = \frac{(b_{24})^{(4)} T_{25}^{*}}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^{*})]}$, $T_{26}^{*} = \frac{(b_{26})^{(4)} T_{25}^{*}}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^{*} given by $\varphi((G_{31})^{*}) = 0$, T_{29}^{*} given by $f(T_{29}^{*}) = 0$ and $G_{28}^{*} = \frac{(a_{28})^{(5)} G_{29}^{*}}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30}^{*} = \frac{(a_{30})^{(5)} G_{29}^{*}}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^{*})]}$	518
$T_{28}^{*} = \frac{(b_{28})^{(5)} T_{29}^{*}}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^{*})]}$, $T_{30}^{*} = \frac{(b_{30})^{(5)} T_{29}^{*}}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*}) = 0$, T_{33}^{*} given by $f(T_{33}^{*}) = 0$ and $G_{32}^{*} = \frac{(a_{32})^{(6)} G_{33}^{*}}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^{*})]}$, $G_{34}^{*} = \frac{(a_{34})^{(6)} G_{33}^{*}}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*} = \frac{(b_{32})^{(6)} T_{33}^{*}}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^{*})]}$, $T_{34}^{*} = \frac{(b_{34})^{(6)} T_{33}^{*}}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*}) = 0$, T_{37}^{*} given by $f(T_{37}^{*}) = 0$ and $G_{36}^{*} = \frac{(a_{36})^{(7)} G_{37}^{*}}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^{*})]}$, $G_{38}^{*} = \frac{(a_{38})^{(7)} G_{37}^{*}}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^{*})]}$ $T_{36}^{*} = \frac{(b_{36})^{(7)} T_{37}^{*}}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^{*})]}$, $T_{38}^{*} = \frac{(b_{38})^{(7)} T_{37}^{*}}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*}) = 0$, T_{41}^{*} given by $f(T_{41}^{*}) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote <u>**Definition of**</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}')^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}')^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}')^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}')^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}')^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(3)}$ *and* $(b_i'')^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}'')^{(3)}}{\partial \mathbb{T}_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i'')^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}')^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}')^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}')^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b'_{20})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T^*_{20}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b'_{21})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T^*_{21}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b'_{22})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T^*_{22}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(4)}$ *and* $(b''_i)^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T^*_{25}) = (q_{25})^{(4)} \quad , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G^*_{24}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G^*_{25}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G^*_{26}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T^*_{24}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T^*_{25}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T^*_{26}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T^*_{29}) = (q_{29})^{(5)} \quad , \frac{\partial (b''_i)^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)} G_{28}^* \mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)} G_{29}^* \mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)} G_{30}^* \mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)} T_{28}^* \mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)} T_{29}^* \mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)} T_{30}^* \mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i'')^{(6)}}{\partial G_j}\left(\left(G_{35}\right)^*\right) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)} G_{32}^* \mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)} G_{33}^* \mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)} G_{34}^* \mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)} T_{32}^* \mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)} T_{33}^* \mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)} T_{34}^* \mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \; , \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \; , \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt}=-\left((a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)\mathbb{G}_{42}+(a_{42})^{(8)}\mathbb{G}_{41}-(q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt}=-\left((b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)\mathbb{T}_{40}+(b_{40})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt}=-\left((b_{41}^{'})^{(8)}-(r_{41})^{(8)}\right)\mathbb{T}_{41}+(b_{41})^{(8)}\mathbb{T}_{40}+\sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt}=-\left((b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\mathbb{T}_{42}+(b_{42})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof: Denote**	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad , T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*})=(q_{45})^{(9)} \quad , \quad \frac{\partial(b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right)=s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt}=-\left((a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\mathbb{G}_{44}+(a_{44})^{(9)}\mathbb{G}_{45}-(q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt}=-\left((a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)\mathbb{G}_{45}+(a_{45})^{(9)}\mathbb{G}_{44}-(q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt}=-\left((a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)\mathbb{G}_{46}+(a_{46})^{(9)}\mathbb{G}_{45}-(q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt}=-\left((b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)\mathbb{T}_{44}+(b_{44})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt}=-\left((b_{45}^{'})^{(9)}-(r_{45})^{(9)}\right)\mathbb{T}_{45}+(b_{45})^{(9)}\mathbb{T}_{44}+\sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt}=-\left((b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\mathbb{T}_{46}+(b_{46})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)}+(b_{15}^{'})^{(1)}-(r_{15})^{(1)}\right)\{\left((\lambda)^{(1)}+(a_{15}^{'})^{(1)}+(p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}G_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^*+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^*\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^*+(b_{21})^{(3)}s_{(20),(20)}T_{20}^*\right)$ $\left(\left((\lambda)^{(3)}\right)^2+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^*+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^*\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^*+(b_{21})^{(3)}s_{(20),(22)}T_{20}^*\right)\}=0$ +	
$((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)})$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^*+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^*\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^*+(b_{25})^{(4)}s_{(24),(25)}T_{25}^*\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^*+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^*\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^*+(b_{25})^{(4)}s_{(24),(24)}T_{24}^*\right)$ $\left(\left((\lambda)^{(4)}\right)^2+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2+\left((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^*+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^*\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^*+(b_{25})^{(4)}s_{(24),(26)}T_{24}^*\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)})$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^*+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^*\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^*+(b_{29})^{(5)}s_{(28),(29)}T_{29}^*\right)$	

$$+\left(\left((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$\Big(\big((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\big)s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\Big)$

$+\Big(\big((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)}\big)(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\Big)$

$\Big(\big((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\big)s_{(45),(44)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\Big)$

$\Big(\big((\lambda)^{(9)}\big)^2 + \big((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\big)(\lambda)^{(9)}\Big)$

$\Big(\big((\lambda)^{(9)}\big)^2 + \big((b_{44}^{'})^{(9)} + (b_{45}^{'})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\big)(\lambda)^{(9)}\Big)$

$+\Big(\big((\lambda)^{(9)}\big)^2 + \big((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\big)(\lambda)^{(9)}\Big)(q_{46})^{(9)}G_{46}$

$+\big((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)}\big)\big((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\big)$

$\Big(\big((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\big)s_{(45),(46)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\Big)\} = 0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION TWENTY ONE

Generalized Supersymmetry Transformations Acting At The Quasi-Exactly Solvable Points

INTRODUCTION—VARIABLES USED

Pseudo-supersymmetric quantum mechanics and isospectral pseudo-Hermitian Hamiltonians Ali Mostafazadeh doi: 10.1016/S0550-3213(02)00347-4

(1) In particular, this factorization applies to (e&eb) PT-symmetric and Hermitian Hamiltonians.
(2) The non-degenerate two-level systems provide (eb) a class of Hamiltonians that are (=) pseudo-Hermitian. They demonstrate the implications of general results for this class in some detail. Copyright © 2002 Elsevier Science B.V. All rights reserved.

Spectral equivalences, Bethe ansatz equations, and reality properties in Script PScript T-symmetric quantum mechanics Patrick Dorey1, Clare Dunning2 and Roberto Tateo1Published 6 July 2001 • Journal of Physics A: Mathematical and General, Volume 34, Number 28

(3) The one-dimensional Schrödinger equation for (e0 the potential x6 + αx2 + l(l + 1)/x2 has (e) many

interesting properties.

(4) For certain values of the parameters l and α the equation are (=) in turn supersymmetric (Witten) and (e&eb) quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD.

(5) In this paper authors signal some further curious features of these theories, namely novel spectral equivalences with (e&eb, =) particular second- and third-order differential equations.

(6) These relationships are obtained via (e&eb) a recently observed connection between the theories of ordinary differential equations and (e&eb) integrable models.

(7) Generalized supersymmetry transformations acting at (e&eb) the quasi-exactly solvable points are also pointed out, and an efficient numerical procedure for (e) the study of these and related problems is described.

(8) Finally authors generalize slightly and then prove (eb) a conjecture due to Bessis, Zinn-Justin, Bender and Boettcher, concerning (e&eb) the reality of the spectra of certain Script PScript T-symmetric quantum mechanical systems.

Deformations of the spin currents by topological screw dislocation and cosmic dispiration Jian-Hua Wang, Kai Ma, Kang Li, Hua-wei Fan

(9) Authors study the spin currents induced by (e) topological screw dislocation and (e&eb) cosmic dispiration.

(10) By using the extended Drude model, authors find (eb) that the spin dependent forces are modified by (e&eb) the nontrivial geometry.

(11) For the topological screw dislocation, only the direction of spin current is bended by (e&eb) deforming the spin polarization vector.

(12) In contrast, the force induced by (e) cosmic dispiration could affect both (e&eb) the direction and magnitude of the spin current.

(13) As a consequence, the spin-Hall conductivity doesn't (e) receive corrections from screw dislocation. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); General Relativity and Quantum Cosmology (gr-qc); Quantum Physics (quant-ph) Journal reference:Ann. Phys. 362, 327(2015) DOI: 10.1016/j.aop.2015.08.004 Cite as: arXiv: 1510.07741 [cond-mat.mes-hall] (or arXiv:1510.07741v1 [cond-mat.mes-hall] for this version

NOTATION

Module One

In particular, this **factorization** applies to (e&eb) PT-symmetric and Hermitian Hamiltonians

G_{13} : Category one of **factorization;** PT-symmetric and Hermitian Hamiltonians

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of PT-symmetric and Hermitian Hamiltonians **;factorization**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

G_{16} : Category one of **PT-symmetric;** Hermitian Hamiltonians

G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of Hermitian Hamiltonians **;PT-symmetric** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three The non-degenerate two-level systems provide (eb) a class of Hamiltonians that are (=) pseudo-Hermitian. They demonstrate the implications of general results for this class in some detail . Copyright © 2002 Elsevier Science B.V. All rights reserved	
G_{20} : Category one of **non-degenerate two-level systems;** class of Hamiltonians that are (=) pseudo-Hermitian. They demonstrate the implications of general results for this class in some detail G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of class of Hamiltonians that are (=) pseudo-Hermitian. They demonstrate the implications of general results for this class in some detail; **non-degenerate two-level systems** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four The non-degenerate two-level systems provide (eb) a class of Hamiltonians that are (=) pseudo-Hermitian	
G_{24} : Category one of non-degenerate two-level systems G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of class of Hamiltonians that are (=) pseudo-Hermitian T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five The non-degenerate two-level systems provide a class of Hamiltonians that are (=) pseudo-Hermitian	
G_{28} : Category one of non-degenerate two-level systems provide a class of Hamiltonians G_{29} : Category two of SAS G_{30} : Category three of SAS	

T_{28} : Category one of pseudo-Hermitian T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six The one-dimensional Schrödinger equation for (e) the potential x6 + αx2 + l(l + 1)/x2 has (e) many interesting properties	
G_{32} : Category one of one-dimensional Schrödinger equation; **potential x6 + αx2 + l(l + 1)/x2 has (e) many interesting properties** G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of **potential x6 + αx2 + l(l + 1)/x2 has (e) many interesting properties;** one-dimensional Schrödinger equation T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven the equation For certain values of the parameters l and α are (=) in turn supersymmetric (Witten) and (e&eb) quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD	
G_{36} : Category one of equation For certain values of the parameters l and α G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of supersymmetric (Witten) and (e&eb) quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight the equation For certain values of the parameters l and α are in turn supersymmetric (Witten) and (e&eb) quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD	
G_{40} : Category one of **equation For certain values of the parameters l and α are in turn supersymmetric (Witten);** quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD	

G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD; **equation For certain values of the parameters l and α are in turn supersymmetric (Witten)** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine the equation For certain values of the parameters l and α are in turn supersymmetric (Witten) and quasi-exactly solvable (Turbiner), and it also appears in (e&eb) Lipatov's approach to high-energy QCD	
G_{44} : Category one of **equation For certain values of the parameters l and α are in turn supersymmetric (Witten) and quasi-exactly solvable (Turbiner), and it also appears;** Lipatov's approach to high-energy QCD G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of Lipatov's approach to high-energy QCD; **equation For certain values of the parameters l and α are in turn supersymmetric (Witten) and quasi-exactly solvable (Turbiner), and it also appears** T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$,	

$(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a''_{20})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four	

The differential system of this model is now (Module numbered Four)	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)} (T_{25}, t) \right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)} (T_{25}, t) \right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)} (T_{25}, t) \right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)} \left((G_{27}), t \right) \right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)} \left((G_{27}), t \right) \right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)} \left((G_{27}), t \right) \right] T_{26}$	24
$+(a''_{24})^{(4)} (T_{25}, t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)} \left((G_{27}), t \right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)} (T_{29}, t) \right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)} (T_{29}, t) \right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)} (T_{29}, t) \right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)} \left((G_{31}), t \right) \right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)} \left((G_{31}), t \right) \right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)} \left((G_{31}), t \right) \right] T_{30}$	30
$+(a''_{28})^{(5)} (T_{29}, t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)} \left((G_{31}), t \right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)} (T_{33}, t) \right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)} (T_{33}, t) \right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)} (T_{33}, t) \right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)} \left((G_{35}), t \right) \right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)} \left((G_{35}), t \right) \right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)} \left((G_{35}), t \right) \right] T_{34}$	36
$+(a''_{32})^{(6)} (T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)} (T_{37}, t) \right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}, t) \right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}, t) \right] G_{38}$	*39*

$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}), t\right) \right] T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}), t\right) \right] T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}), t\right) \right] T_{38}$	42
$+(a_{36}^{''})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}, t) \right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}, t) \right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}), t\right) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}), t\right) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}), t\right) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left((G_{47}), t\right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left((G_{47}), t\right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left((G_{47}), t\right) \right] T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}\left((G_{47}), t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a_{14}^{'})^{(1)} \boxed{+(a_{14}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a_{15}^{'})^{(1)} \boxed{+(a_{15}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	57
Where $\boxed{(a_{13}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{14}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{15}^{''})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for	

category 1, 2 and 3

$\boxed{+(a_{20}'')^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}'')^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}'')^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a_{40}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}'')^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b_{13}')^{(1)} \boxed{-(b_{13}'')^{(1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \quad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b_{14}')^{(1)} \boxed{-(b_{14}'')^{(1)}(G,t)} \boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14} \quad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b_{15}')^{(1)} \boxed{-(b_{15}'')^{(1)}(G,t)} \boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15} \quad 60$$

Where $\boxed{-(b_{13}'')^{(1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	64

$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\begin{bmatrix}(b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,)}(G,t)}\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}\end{bmatrix}T_{17}$	65
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\begin{bmatrix}(b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,)}(G,t)}\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}\end{bmatrix}T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\begin{bmatrix}(a'_{20})^{(3)}\boxed{+(a''_{20})^{(3)}(T_{21},t)}\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{20}$	67
$\frac{dG_{21}}{dt}=(a_{21})^{(3)}G_{20}-\begin{bmatrix}(a'_{21})^{(3)}\boxed{+(a''_{21})^{(3)}(T_{21},t)}\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{21}$	68
$\frac{dG_{22}}{dt}=(a_{22})^{(3)}G_{21}-\begin{bmatrix}(a'_{22})^{(3)}\boxed{+(a''_{22})^{(3)}(T_{21},t)}\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{20}$	*70*
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21}$	*71*
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22}$	*72*
$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3* $\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*	

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\left[\begin{matrix}(a'_{24})^{(4)}\boxed{+(a''_{24})^{(4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{24}$	73
$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\left[\begin{matrix}(a'_{25})^{(4)}\boxed{+(a''_{25})^{(4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{25}$	74
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\left[\begin{matrix}(a'_{26})^{(4)}\boxed{+(a''_{26})^{(4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{26}$	75
$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1,2\ \ 3$ $\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ $are\ second\ \ augmentation\ coefficient\ \ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ \ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ $are\ fourth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ $are\ fifth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ $are\ sixth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ $are\ seventh\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ $are\ eighth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[\begin{matrix}(b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{24}$	76

$$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\begin{bmatrix}(b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{25}$$	77
$$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\begin{bmatrix}(b'_{26})^{(4)}\boxed{-(b''_{26})^{(4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{26}$$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\begin{bmatrix}(a'_{28})^{(5)}\boxed{+(a''_{28})^{(5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{28}$$	79
$$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\begin{bmatrix}(a'_{29})^{(5)}\boxed{+(a''_{29})^{(5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{29}$$	80
$$\frac{dG_{30}}{dt}=(a_{30})^{(5)}G_{29}-\begin{bmatrix}(a'_{30})^{(5)}\boxed{+(a''_{30})^{(5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{30}$$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation*	

$coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation$ $coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{30}$	84
$where$ $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ $are\ first\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ $are\ second\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition	

coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$	85
$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$	86
$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32}$	88

$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33}$	89
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34}$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	92

$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	*93*
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	

Where $\boxed{-(b_{36}'')^{(7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a_{40}')^{(8)} \boxed{+(a_{40}'')^{(8)}(T_{41},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a_{41}')^{(8)} \boxed{+(a_{41}'')^{(8)}(T_{41},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a_{42}')^{(8)} \boxed{+(a_{42}'')^{(8)}(T_{41},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$$

Where $\boxed{+(a_{40}'')^{(8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}'')^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} =$$

$$(b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$	
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$	
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3	

$-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)},(a'_i)^{(1)},(a''_i)^{(1)},(b_i)^{(1)},(b'_i)^{(1)},(b''_i)^{(1)}>0, \quad i,j=13,14,15$ The functions $(a''_i)^{(1)},(b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t)\le(p_i)^{(1)}\le(\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t)\le \ (r_i)^{(1)}\le(b'_i)^{(1)}\le(\hat{B}_{13})^{(1)}$	*97*
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They satisfy Lipschitz condition: $\lvert(a''_i)^{(1)}(T'_{14},t)-(a''_i)^{(1)}(T_{14},t)\rvert\le(\hat{k}_{13})^{(1)}\lvert T_{14}-T'_{14}\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b''_i)^{(1)}(G',t)-(b''_i)^{(1)}(G,t)\rvert<(\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\lvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a''_i)^{(1)}(T'_{14},t)$ and $(a''_i)^{(1)}(T_{14},t)$. (T'_{14},t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}]$. It is to be noted that $(a''_i)^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a''_i)^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \ ,\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a'_i)^{(1)},(b_i)^{(1)},(b'_i)^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}, i=13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i')^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i')^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0, \quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t)\leq(p_i)^{(2)}\leq(\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t)\leq (r_i)^{(2)}\leq(b_i')^{(2)}\leq(\hat{B}_{16})^{(2)}$	103
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Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)}, (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\rvert\leq(\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}\left((G_{19}),t\right)\rvert<(\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})'\rvert\lvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i^{'})^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i^{'})^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and$(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)},$ are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} \ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. __Definition of__ $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25}, t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}), t) \leq (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2 \to \infty}(a_i^{''})^{(4)}(T_{25}, t) = (p_i)^{(4)}$ $\lim_{G \to \infty}(b_i^{''})^{(4)}((G_{27}), t) = (r_i)^{(4)}$ __Definition of__ $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	118
They satisfy Lipschitz condition: $\|(a_i^{''})^{(4)}(T_{25}^{'}, t) - (a_i^{''})^{(4)}(T_{25}, t)\| \leq (\hat{k}_{24})^{(4)}\|T_{25} - T_{25}^{'}\|e^{-(\hat{M}_{24})^{(4)}t}$ $\|(b_i^{''})^{(4)}((G_{27})^{'}, t) - (b_i^{''})^{(4)}((G_{27}), t)\| < (\hat{k}_{24})^{(4)}\|\|(G_{27}) - (G_{27})^{'}\|\|e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'}, t)$ and$(a_i^{''})^{(4)}(T_{25}, t)$. $(T_{25}^{'}, t)$ and (T_{25}, t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
__Definition of__ $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}, \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

<u>**Definition of**</u> $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i^{'})^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i^{'})^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t) \le (p_i)^{(5)} \le (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}),t) \le (r_i)^{(5)} \le (b_i^{'})^{(5)} \le (\hat{B}_{28})^{(5)}$	122
$lim_{T_2 \to \infty}(a_i^{''})^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G \to \infty}(b_i^{''})^{(5)}(G_{31},t) = (r_i)^{(5)}$ <u>**Definition of**</u> $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(5)}(T_{29}^{'},t) - (a_i^{''})^{(5)}(T_{29},t)\rvert \le (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}^{'}\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i^{''})^{(5)}((G_{31})^{'},t) - (b_i^{''})^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})^{'}\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and $(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
<u>Definition of</u> $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)}$ *and* $(\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \le (p_i)^{(6)} \le (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \le (r_i)^{(6)} \le (b_i')^{(6)} \le (\hat{B}_{32})^{(6)}$	127
$lim_{T_2 \to \infty}(a_i'')^{(6)}(T_{33}, t) = (p_i)^{(6)}$ $\lim_{G \to \infty}(b_i'')^{(6)}((G_{35}), t) = (r_i)^{(6)}$ **<u>Definition of</u>** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\|(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\| \le (\hat{k}_{32})^{(6)}\|T_{33} - T_{33}'\|e^{-(\hat{M}_{32})^{(6)}t}$ $\|(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}((G_{35}), t)\| < (\hat{k}_{32})^{(6)}\|\|(G_{35}) - (G_{35})'\|\|e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants	129

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)}(\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)}(\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(QQQQQ) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (RRRRR) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
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They satisfy Lipschitz condition: $\|(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\| \leq (\hat{k}_{36})^{(7)}\|T_{37} - T_{37}'\|e^{-(\hat{M}_{36})^{(7)}t}$ $\|(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\| < (\hat{k}_{36})^{(7)}\|\|(G_{39}) - (G_{39})'\|\|e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (UUUUU) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (VVVVV) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and\ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i^{'})^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i^{'})^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i^{'})^{(8)}, (a_i^{''})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (b_i^{''})^{(8)} > 0, \quad i, j = 40,41,42$	136
The functions $(a_i^{''})^{(8)}, (b_i^{''})^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i^{''})^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i^{''})^{(8)}((G_{43}), t) \leq (r_i)^{(8)} \leq (b_i^{'})^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2 \to \infty} (a_i^{''})^{(8)} (T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G \to \infty} (b_i^{''})^{(8)} \left((G_{43}), t\right) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\|(a_i^{''})^{(8)}(T_{41}^{'}, t) - (a_i^{''})^{(8)}(T_{41}, t)\| \leq (\hat{k}_{40})^{(8)}\|T_{41} - T_{41}^{'}\|e^{-(\hat{M}_{40})^{(8)}t}$	142

$\|(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}((G_{43}),t)\| < (\hat{k}_{40})^{(8)}\|\|(G_{43}) - (G_{43})'\|\|e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}$, $\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i')^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i')^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t) \le (p_i)^{(9)} \le (\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t) \le (r_i)^{(9)} \le (b_i')^{(9)} \le (\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t) = (p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t) = (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i = 44,45,46$	
They satisfy Lipschitz condition:	

$$|(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)|\leq(\hat{k}_{44})^{(9)}|T_{45}-T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)|<(\hat{k}_{44})^{(9)}||(G_{47})-(G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and$(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}},\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$$

Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(p_i)^{(9)},(r_i)^{(9)},i=44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i')^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i')^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0),T_i(0)$:

$G_i(t)\leq(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $G_i(0)=G_i^0>0$

$T_i(t)\leq(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $T_i(0)=T_i^0>0$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0),T_i(0)$

$G_i(t)\leq(\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0)=G_i^0>0$

$T_i(t)\leq(\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0)=T_i^0>0$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$G_i(t)\leq(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0)=G_i^0>0$

$T_i(t) \leq \ (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36}\right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40}\right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44}\right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a'_{20})^{(3)} + a''_{20})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{32})^{(6)}$, $T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{36})^{(7)}$, $T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}\left(s_{(44)}\right) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{44}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}\left(s_{(44)}\right) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{45}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}\left(s_{(44)}\right) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{46}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}\left(s_{(44)}\right) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{44}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}\left(s_{(44)}\right) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{45}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}\left(s_{(44)}\right) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{46}\left(s_{(44)}\right)\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0) e^{-(\hat{M}_{24})^{(4)} t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left[\left((\hat{P}_{24})^{(4)} + G_{25}^0 \right) e^{\left(-\frac{(\hat{P}_{24})^{(4)} + G_{25}^0}{G_{25}^0} \right)} + (\hat{P}_{24})^{(4)} \right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176

From which it follows that $(G_{32}(t) - G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)} + G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)} + (\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(u) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)}\left(G_{37}^0 + (\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)}t\right)G_{37}^0 + \frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t} - 1\right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)}\left(G_{41}^0 + (\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right] ds_{(40)} =$ $\left(1 + (a_{40})^{(8)}t\right)G_{41}^0 + \frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t} - 1\right)$	180
From which it follows that $(G_{40}(t) - G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)} + G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)} + (\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0 + \int_0^t \left[(a_{44})^{(9)}\left(G_{45}^0 + (\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right] ds_{(44)} =$ $\left(1 + (a_{44})^{(9)}t\right)G_{45}^0 + \frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t} - 1\right)$	
From which it follows that $(G_{44}(t) - G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)} + G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)} + (\hat{P}_{44})^{(9)}\right]$	

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$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
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In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **Definition of** $(\widetilde{G_{43}}),(\widetilde{T_{43}})$: $\left((\widetilde{G_{43}}),(\widetilde{T_{43}})\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results	271

$\left\|\tilde{G}_{40}^{(1)}-\tilde{G}_{i}^{(2)}\right\| \leq \int_0^t (a_{40})^{(8)} \left\|G_{41}^{(1)}-G_{41}^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} \, ds_{(40)} +$ $\int_0^t \{(a_{40}')^{(8)} \left\|G_{40}^{(1)}-G_{40}^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} +$ $(a_{40}'')^{(8)}(T_{41}^{(1)}, s_{(40)}) \left\|G_{40}^{(1)}-G_{40}^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} +$ $G_{40}^{(2)} \left\|(a_{40}'')^{(8)}(T_{41}^{(1)}, s_{(40)}) - (a_{40}'')^{(8)}(T_{41}^{(2)}, s_{(40)})\right\| \; e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}}\} ds_{(40)}$	
Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
$\left\|(G_{43})^{(1)}-(G_{43})^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} t} \leq$ $\frac{1}{(\widehat{M}_{40})^{(8)}}\left((a_{40})^{(8)} + (a_{40}')^{(8)} + (\widehat{A}_{40})^{(8)} + (\widehat{P}_{40})^{(8)}(\widehat{k}_{40})^{(8)}\right) d\left(\left((G_{43})^{(1)}, (T_{43})^{(1)};\ (G_{43})^{(2)}, (T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
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Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1 / (a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2 / (a_{42}')^{(8)}$	276

If G_{41} or G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
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Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}^{''})^{(8)}\big((G_{43})(t),t(t),t\big) = (b_{42}^{'})^{(8)}$	279
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$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) = \sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})}, \widetilde{(T_{47})} : (\widetilde{(G_{47})}, \widetilde{(T_{47})}) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \le \int_0^t (a_{44})^{(9)} \left|G_{45}^{(1)} - G_{45}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$
$\int_0^t \{(a_{44}^{'})^{(9)} \left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$(a_{44}^{''})^{(9)} (T_{45}^{(1)}, s_{(44)}) \left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)} |(a_{44}^{''})^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a_{44}^{''})^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$\left|(G_{47})^{(1)} - G^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} t} \le$
$\frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}^{'})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)}\right) d \left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)} \right) \right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}^{''})^{(9)}$ and $(b_{44}^{''})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$G_i(t) \ge G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \ge 0$

$T_i(t) \ge T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \le \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \le \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \le \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t),t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t),t) = (b_{46}^{'})^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14},t) + (a_{14}^{''})^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \; if \; (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \; (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$	283

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)}, \; if \; (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$

and analogously 284

$(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)}, \; if \; (u_0)^{(1)} < (u_1)^{(1)}$

$(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if \; (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$

and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$

$(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if \; (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$

are defined

Then the solution of global equations satisfies the inequalities 285

$$G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$$

where $(p_i)^{(1)}$ is defined by equation

$$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$$

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$$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq \right.$$

$$\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$$

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$$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)} + (r_{13})^{(1)})t}}$$

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$$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)} + (r_{13})^{(1)})t}$$

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$$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)} - (b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$$

$$\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)} + (r_{13})^{(1)} + (R_2)^{(1)})}\left[e^{((R_1)^{(1)} + (r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$$

Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- 290

Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$

$(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$

$(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$

$(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$

Behavior of the solutions of equation 291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}\left((G_{19}), t\right) - (b''_{17})^{(2)}\left((G_{19}), t\right) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0$, $(\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0$, $(u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0$, $(\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0$, $(\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}$, ***if*** $(\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}$, ***if*** $(\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $(\nu_0)^{(2)} = \frac{G^0_{16}}{G^0_{17}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}$, ***if*** $(\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}$, ***if*** $(u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}$, ***if*** $(u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $(u_0)^{(2)} = \frac{T^0_{16}}{T^0_{17}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}$, ***if*** $(\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a'_{18})^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a'_{18})^{(2)}t}\right] + G_{18}^0 e^{-(a'_{18})^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b'_{18})^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b'_{18})^{(2)}t}\right] + T_{18}^0 e^{-(b'_{18})^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a'_{16})^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b'_{16})^{(2)}$ $(R_2)^{(2)} = (b'_{18})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a'_{20})^{(3)} + (a'_{21})^{(3)} - (a''_{20})^{(3)}(T_{21}, t) + (a''_{21})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b'_{20})^{(3)} + (b'_{21})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) - (b''_{21})^{(3)}\left((G_{23}), t\right) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0$, $(\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0$, $(u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{v}_1)^{(3)} > 0$, $(\bar{v}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(v^{(3)}\right)^2 + (\sigma_2)^{(3)}v^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
<u>**Definition of**</u> $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}\ ,\boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ ,\boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})}\left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)} - (b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)})}\left[e^{((R_1)^{(3)} + (r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- 328

Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$

$(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$

$(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$

$(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$

Behavior of the solutions of equation

Theorem: If we denote and define

Definition of $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$:

$(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying

$-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$

Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: 329

By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$

and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and

Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: 330

By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$

and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$

Definition of $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:-

If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by

$(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ ***if*** $(\nu_0)^{(4)} < (\nu_1)^{(4)}$

$(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)},$ ***if*** $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)},$

and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$

$(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ ***if*** $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$

and analogously 331

$(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ ***if*** $(u_0)^{(4)} < (u_1)^{(4)}$

$(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)},$ ***if*** $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)},$

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)} t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)} t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)})}\left[e^{((S_1)^{(4)} - (p_{24})^{(4)})t} - e^{-(S_2)^{(4)} t}\right] + G_{26}^0 e^{-(S_2)^{(4)} t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)} t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)} + (r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)} t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)} + (r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)} - (b'_{26})^{(4)})}\left[e^{(R_1)^{(4)} t} - e^{-(b'_{26})^{(4)} t}\right] + T_{26}^0 e^{-(b'_{26})^{(4)} t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)} + (r_{24})^{(4)} + (R_2)^{(4)})}\left[e^{((R_1)^{(4)} + (r_{24})^{(4)})t} - e^{-(R_2)^{(4)} t}\right] + T_{26}^0 e^{-(R_2)^{(4)} t}$	336
<u>**Definition of**</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a'_{24})^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b'_{24})^{(4)}$ $(R_2)^{(4)} = (b'_{26})^{(4)} - (r_{26})^{(4)}$	337
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a'_{28})^{(5)} + (a'_{29})^{(5)} - (a''_{28})^{(5)}(T_{29}, t) + (a''_{29})^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b'_{28})^{(5)} + (b'_{29})^{(5)} - (b''_{28})^{(5)}((G_{31}), t) - (b''_{29})^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>**Definition of**</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},$ ***if*** $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},$ ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)},$ ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)}G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}^{'})^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b_{30}^{'})^{(5)}t}\right]+T_{30}^0 e^{-(b_{30}^{'})^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}^{'})^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}^{'})^{(5)}$ $(R_2)^{(5)} = (b_{30}^{'})^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} - (a_{32}^{''})^{(6)}(T_{33}, t) + (a_{33}^{''})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b_{32}^{'})^{(6)} + (b_{33}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35}), t) - (b_{33}^{''})^{(6)}((G_{35}), t) \leq -(\tau_1)^{(6)}$	349
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},$ $\boldsymbol{if}$ $(\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)},$ $\boldsymbol{if}$ $(\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)},$ and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},$ $\boldsymbol{if}$ $(\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)}G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)}T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)}T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
<u>**Definition of**</u> $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}] + G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}')^{(7)}$ $(R_2)^{(7)} = (b_{38}')^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}')^{(8)} + (a_{41}')^{(8)} - (a_{40}'')^{(8)}(T_{41}, t) + (a_{41}'')^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}')^{(8)} + (b_{41}')^{(8)} - (b_{40}'')^{(8)}\big((G_{43}), t\big) - (b_{41}'')^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)},$ and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},$ ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},$ ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)},$ ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{\left((S_1)^{(8)}-(p_{40})^{(8)}\right)t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{\left((S_1)^{(8)}-(p_{40})^{(8)}\right)t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}\left((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)}\right)}\left[e^{\left((S_1)^{(8)}-(p_{40})^{(8)}\right)t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}\left((S_1)^{(8)}-(a_{42}')^{(8)}\right)}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)}T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)}T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a_{44}')^{(9)} + (a_{45}')^{(9)} - (a_{44}'')^{(9)}(T_{45}, t) + (a_{45}'')^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b_{44}')^{(9)} + (b_{45}')^{(9)} - (b_{44}'')^{(9)}((G_{47}), t) - (b_{45}'')^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \; \boldsymbol{if} \; (\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, ***if*** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,
and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, ***if*** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, ***if*** $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, ***if*** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,
and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, ***if*** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$
are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$
$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}\left[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}\right] + G_{46}^0 e^{-(a_{46}')^{(9)}t}\Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$$(R_2)^{(9)} = (b_{46}^{'})^{(9)} - (r_{46})^{(9)}$$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right) - (a_{14}^{''})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
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Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
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From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
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Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{24}'')^{(4)} = (a_{25}'')^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b_{24}'')^{(4)} = (b_{25}'')^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}')^{(5)} - (a_{29}')^{(5)} + (a_{28}'')^{(5)}(T_{29},t)\right) - (a_{29}'')^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)},\quad\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)},\quad\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$ if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}, \quad \boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}, \quad \boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)}=\frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0<(\nu_1)^{(9)}<(\nu_0)^{(9)}=\frac{G_{44}^0}{G_{45}^0}<(\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0<(\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)}=\frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t)=\frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t)=\frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}'')^{(9)}=(a_{45}'')^{(9)}, then\ (\sigma_1)^{(9)}=(\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)}=(\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)}=(\nu_1)^{(9)}$ then $\nu^{(9)}(t)=(\nu_0)^{(9)}$ and as a consequence $G_{44}(t)=(\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}'')^{(9)}=(b_{45}'')^{(9)}, then\ (\tau_1)^{(9)}=(\tau_2)^{(9)}$ and then $(u_1)^{(9)}=(\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)}=(u_1)^{(9)}$ then $T_{44}(t)=(u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i'')^{(1)} and\ (b_i'')^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}')^{(1)}(a_{14}')^{(1)}-(a_{13})^{(1)}(a_{14})^{(1)}<0$$

$$(a_{13}')^{(1)}(a_{14}')^{(1)}-(a_{13})^{(1)}(a_{14})^{(1)}+(a_{13})^{(1)}(p_{13})^{(1)}+(a_{14}')^{(1)}(p_{14})^{(1)}+(p_{13})^{(1)}(p_{14})^{(1)}>0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ *with* $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)}$ *and* $(b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ *with* $(p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)}$ *and* $(b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ *with* $(p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)}$ *and* $(b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ *with* $(p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b'_{44})^{(9)}(r_{45})^{(9)} - (b'_{45})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) +$ $(a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (u) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T^*_{17} for which $f(T^*_{17}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	495
Definition and uniqueness of T^*_{21} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T^*_{21} for which $f(T^*_{21}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$	496
Definition and uniqueness of T^*_{25} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T^*_{25} for which $f(T^*_{25}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a'_{24})^{(4)}+(a''_{24})^{(4)}(T^*_{25})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a'_{26})^{(4)}+(a''_{26})^{(4)}(T^*_{25})]}$	497
Definition and uniqueness of T^*_{29} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T^*_{29} for which $f(T^*_{29}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a'_{28})^{(5)}+(a''_{28})^{(5)}(T^*_{29})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a'_{30})^{(5)}+(a''_{30})^{(5)}(T^*_{29})]}$	498
Definition and uniqueness of T^*_{33} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T^*_{33} for which $f(T^*_{33}) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T^*_{33})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T^*_{33})]}$	
Definition and uniqueness of T^*_{37} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T^*_{37} for which $f(T^*_{37}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T^*_{37})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T^*_{37})]}$	500
Definition and uniqueness of T^*_{41} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T^*_{41} for which $f(T^*_{41}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T^*_{41})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T^*_{41})]}$	501
Definition and uniqueness of T^*_{45} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T^*_{45} for which $f(T^*_{45}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T^*_{45})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T^*_{45})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b'_{13})^{(1)}(b''_{14})^{(1)}(G) + (b'_{14})^{(1)}(b''_{13})^{(1)}(G)\right] + (b''_{13})^{(1)}(G)(b''_{14})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G^*_{14} such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b'_{16})^{(2)}(b''_{17})^{(2)}(G_{19}) + (b'_{17})^{(2)}(b''_{16})^{(2)}(G_{19})\right] + (b''_{16})^{(2)}(G_{19})(b''_{17})^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18})$, G_{16}, G_{18} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22})$, G_{20}, G_{22} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27}) + (b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right] + (b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26})$, G_{24}, G_{26} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31}) + (b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right] + (b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30})$, G_{28}, G_{30} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35}) + (b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right] + (b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34})$, G_{32}, G_{34} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39}) + (b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right] + (b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38})$, G_{36}, G_{38} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - \left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^{*} given by $\varphi(G_{27})=0$, T_{25}^{*} given by $f(T_{25}^{*})=0$ and $G_{24}^{*}=\frac{(a_{24})^{(4)}G_{25}^{*}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26}^{*}=\frac{(a_{26})^{(4)}G_{25}^{*}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	516
$T_{24}^{*}=\frac{(b_{24})^{(4)}T_{25}^{*}}{[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}((G_{27})^{*})]}$, $T_{26}^{*}=\frac{(b_{26})^{(4)}T_{25}^{*}}{[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}((G_{27})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^{*} given by $\varphi((G_{31})^{*})=0$, T_{29}^{*} given by $f(T_{29}^{*})=0$ and $G_{28}^{*}=\frac{(a_{28})^{(5)}G_{29}^{*}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*}=\frac{(a_{30})^{(5)}G_{29}^{*}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	518
$T_{28}^{*}=\frac{(b_{28})^{(5)}T_{29}^{*}}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*}=\frac{(b_{30})^{(5)}T_{29}^{*}}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*})=0$, T_{33}^{*} given by $f(T_{33}^{*})=0$ and $G_{32}^{*}=\frac{(a_{32})^{(6)}G_{33}^{*}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*}=\frac{(a_{34})^{(6)}G_{33}^{*}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*}=\frac{(b_{32})^{(6)}T_{33}^{*}}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^{*})]}$, $T_{34}^{*}=\frac{(b_{34})^{(6)}T_{33}^{*}}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*})=0$, T_{37}^{*} given by $f(T_{37}^{*})=0$ and $G_{36}^{*}=\frac{(a_{36})^{(7)}G_{37}^{*}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}^{*}=\frac{(a_{38})^{(7)}G_{37}^{*}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$ $T_{36}^{*}=\frac{(b_{36})^{(7)}T_{37}^{*}}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^{*})]}$, $T_{38}^{*}=\frac{(b_{38})^{(7)}T_{37}^{*}}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*})=0$, T_{41}^{*} given by $f(T_{41}^{*})=0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote <u>**Definition of**</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}')^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}')^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}')^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}')^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}')^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(3)}$ *and* $(b_i'')^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}'')^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i'')^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}')^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}')^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}')^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b'_{20})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T^*_{20}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b'_{21})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T^*_{21}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b'_{22})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T^*_{22}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(4)}$ *and* $(b''_i)^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T^*_{25}) = (q_{25})^{(4)} \quad , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G^*_{24}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G^*_{25}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G^*_{26}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T^*_{24}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T^*_{25}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T^*_{26}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T^*_{29}) = (q_{29})^{(5)} \quad , \frac{\partial (b''_i)^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial(b_i'')^{(6)}}{\partial G_j}\left(\left(G_{35}\right)^*\right) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i^{''})^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof: Denote**	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}G_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$ +	
$((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)})$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)})$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$	

$$+\left(\left((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(\left((\lambda)^{(9)}+(a_{45}')^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION TWENTY TWO

Conjecture Due To Bessis, Zinn-Justin, Bender And Boettcher

INTRODUCTION—VARIABLES USED

Spectral equivalences, Bethe ansatz equations, and reality properties in Script PScript T-symmetric quantum mechanics Patrick Dorey1, Clare Dunning2 and Roberto Tateo1Published 6 July 2001 • Journal of Physics A: Mathematical and General, Volume 34, Number 28

(1) In this paper authors signal some further curious features of these theories, namely novel spectral equivalences with (e&eb, =) particular second- and third-order differential equations.
(2) These relationships are obtained via (e&eb) a recently observed connection between the theories of ordinary differential equations and (e&eb) integrable models.
(3) Generalized supersymmetry transformations acting at (e&eb) the quasi-exactly solvable points are also pointed out, and an efficient numerical procedure for (e) the study of these and related problems is described.
(4) Finally authors generalize slightly and then prove (eb) a conjecture due to Bessis, Zinn-Justin, Bender and Boettcher, concerning (e&eb) the reality of the spectra of certain Script PScript T-

symmetric quantum mechanical systems.

Deformations of the spin currents by topological screw dislocation and cosmic dispiration Jian-Hua Wang, Kai Ma, Kang Li, Hua-wei Fan

(5) Authors study the spin currents induced by (e) topological screw dislocation and (e&eb) cosmic dispiration.
(6) By using the extended Drude model, authors find (eb) that the spin dependent forces are modified by (e&eb) the nontrivial geometry.
(7) For the topological screw dislocation, only the direction of spin current is bended by (e&eb) deforming the spin polarization vector.
(8) In contrast, the force induced by (e) cosmic dispiration could affect both (e&eb) the direction and magnitude of the spin current.
(9) As a consequence, the spin-Hall conductivity doesn't (e) receive corrections from screw dislocation. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); General Relativity and Quantum Cosmology (gr-qc); Quantum Physics (quant-ph) Journal reference:Ann. Phys. 362, 327(2015) DOI: 10.1016/j.aop.2015.08.004 Cite as: arXiv: 1510.07741 [cond-mat.mes-hall] (or arXiv:1510.07741v1 [cond-mat.mes-hall] for this version

NOTATION

Module One

In this paper authors signal some further curious features of these theories, namely novel spectral equivalences with (e&eb, =) particular second- and third-order differential equations

G_{13} : Category one of **novel spectral equivalences;** particular second- and third-order differential equations

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of particular second- and third-order differential equations; **novel spectral equivalences**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

These relationships are obtained via (e&eb) a recently observed connection between the theories of ordinary differential equations and (e&eb) integrable models

G_{16} : Category one of **relationships are obtained;** recently observed connection between the theories of ordinary differential equations and (e&eb) integrable models

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of recently observed connection between the theories of ordinary differential equations and (e&eb) integrable models **;relationships are obtained**

T_{17} : Category two of SAS

T_{18} : Category three of SAS	
Module three recently observed connection between the theories of ordinary differential equations and (e&eb) integrable models	
G_{20} : Category one of **theories of ordinary differential equations;** integrable models G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of integrable models **;theories of ordinary differential equations** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four **Generalized supersymmetry transformations** acting at (e&eb) the quasi-exactly solvable points are also pointed out, and an efficient numerical procedure for (e) the study of these and related problems is described	
G_{24} : Category one of **Generalized supersymmetry transformations;** quasi-exactly solvable points G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of quasi-exactly solvable points ;**Generalized supersymmetry transformations** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five efficient numerical procedure for (e) the study of these and related problems	
G_{28} : Category one of **efficient numerical procedure;** study of these and related problems G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of study of these and related problems; **efficient numerical procedure** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six Finally authors generalize slightly and then prove (eb) a **conjecture due to Bessis, Zinn-Justin, Bender and Boettcher,** concerning (e&eb) the reality of the spectra of certain Script PScript T-symmetric quantum	

mechanical systems.	
G_{32} : Category one of **conjecture due to Bessis, Zinn-Justin, Bender and Boettcher;** reality of the spectra of certain Script PScript T-symmetric quantum mechanical systems. G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of reality of the spectra of certain Script PScript T-symmetric quantum mechanical systems.; **conjecture due to Bessis, Zinn-Justin, Bender and Boettcher** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven Authors study the **spin currents induced** by (e) topological screw dislocation and (e&eb) cosmic dispiration	
G_{36} : Category one of **spin currents induced;** topological screw dislocation and (e&eb) cosmic dispiration G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of topological screw dislocation and (e&eb) cosmic dispiration **;spin currents induced** T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight topological screw dislocation and (e&eb) cosmic dispiration	
G_{40} : Category one of **topological screw dislocation;** cosmic dispiration G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of cosmic dispiration **;topological screw dislocation** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine By using the extended Drude model, authors find (eb) that the spin dependent forces are modified by (e&eb) the nontrivial geometry	

G_{44} : Category one of extended Drude model G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of spin dependent forces are modified by (e&eb) the nontrivial geometry T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t)\right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t)\right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t)\right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t)\right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t)\right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two	

The differential system of this model is now (Module numbered two)	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27

$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	*42*
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	

$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[\begin{matrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{13}$	*55*
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{14}$	*56*
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[\begin{matrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right]G_{15}$	*57*
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	

$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{16}$	*61*
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{17}$	*62*

$$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \begin{bmatrix} (a_{18}')^{(2)} \boxed{+(a_{18}'')^{(2)}(T_{17},t)} \boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$$ 63

Where $\boxed{+(a_{16}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{44}'')^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \begin{bmatrix} (b_{16}')^{(2)} \boxed{-(b_{16}'')^{(2)}(G_{19},t)} \boxed{-(b_{13}'')^{(1,1,)}(G,t)} \boxed{-(b_{20}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16}$$ 64

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \begin{bmatrix} (b_{17}')^{(2)} \boxed{-(b_{17}'')^{(2)}(G_{19},t)} \boxed{-(b_{14}'')^{(1,1,)}(G,t)} \boxed{-(b_{21}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17}$$ 65

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \begin{bmatrix} (b_{18}')^{(2)} \boxed{-(b_{18}'')^{(2)}(G_{19},t)} \boxed{-(b_{15}'')^{(1,1,)}(G,t)} \boxed{-(b_{22}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18}$$ 66

where $\boxed{-(b_{16}'')^{(2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{13}'')^{(1,1,)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1,2 and 3	
$-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1,2 and 3	
$-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1,2 and 3	
$-(b''_{36})^{(7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3	
$-(b''_{40})^{(8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3	
$-(b''_{44})^{(9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t) + (a''_{16})^{(2,2,2)}(T_{17},t) + (a''_{13})^{(1,1,1,)}(T_{14},t) \\ +(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t) + (a''_{28})^{(5,5,5,5,5,5)}(T_{29},t) + (a''_{32})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{36})^{(7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8)}(T_{41},t) + (a''_{44})^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t) + (a''_{17})^{(2,2,2)}(T_{17},t) + (a''_{14})^{(1,1,1,)}(T_{14},t) \\ +(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t) + (a''_{29})^{(5,5,5,5,5,5)}(T_{29},t) + (a''_{33})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{37})^{(7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t) + (a''_{18})^{(2,2,2)}(T_{17},t) + (a''_{15})^{(1,1,1,)}(T_{14},t) \\ +(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t) + (a''_{30})^{(5,5,5,5,5,5)}(T_{29},t) + (a''_{34})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{38})^{(7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{22}$	69
$+(a''_{20})^{(3)}(T_{21},t)$, $+(a''_{21})^{(3)}(T_{21},t)$, $+(a''_{22})^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3 $+(a''_{40})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20}$	70
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21}$	71
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22}$	72
$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3* $\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[\begin{matrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{24}$	73
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[\begin{matrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{25}$	74

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$$ 75

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24}$$ 76

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25}$$ 77

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$$ 78

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3 $-(b''_{16})^{(2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2)}(G_{19},t)$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $-(b''_{20})^{(3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3)}(G_{23},t)$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $-(b''_{46})^{(9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29},t) + (a''_{24})^{(4,4,)}(T_{25},t) + (a''_{32})^{(6,6,6)}(T_{33},t) \\ + (a''_{13})^{(1,1,1,1,1)}(T_{14},t) + (a''_{16})^{(2,2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3,3)}(T_{21},t) \\ + (a''_{36})^{(7,7,7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8,8,8)}(T_{41},t) + (a''_{44})^{(9,9,9,9,9)}(T_{45},t) \end{matrix}\right] G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29},t) + (a''_{25})^{(4,4,)}(T_{25},t) + (a''_{33})^{(6,6,6)}(T_{33},t) \\ + (a''_{14})^{(1,1,1,1,1)}(T_{14},t) + (a''_{17})^{(2,2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3,3)}(T_{21},t) \\ + (a''_{37})^{(7,7,7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9,9,9)}(T_{45},t) \end{matrix}\right] G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29},t) + (a''_{26})^{(4,4,)}(T_{25},t) + (a''_{34})^{(6,6,6)}(T_{33},t) \\ + (a''_{15})^{(1,1,1,1,1)}(T_{14},t) + (a''_{18})^{(2,2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3,3)}(T_{21},t) \\ + (a''_{38})^{(7,7,7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9,9,9)}(T_{45},t) \end{matrix}\right] G_{30}$	81
Where $+(a''_{28})^{(5)}(T_{29},t)$, $+(a''_{29})^{(5)}(T_{29},t)$, $+(a''_{30})^{(5)}(T_{29},t)$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $+(a''_{24})^{(4,4,)}(T_{25},t)$, $+(a''_{25})^{(4,4,)}(T_{25},t)$, $+(a''_{26})^{(4,4,)}(T_{25},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{32})^{(6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)$ are fourth augmentation coefficients for category 1,2, and 3 $+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)$ are fifth augmentation coefficients for category 1,2,and 3 $+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)$ are sixth augmentation coefficients for category 1,2, 3 $+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1,2, 3 $+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)$ are eighth augmentation coefficients for category 1,2, 3 $+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)$ are ninth augmentation	

coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$	85
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$	86

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[\begin{matrix} (a_{34}^{'})^{(6)} \boxed{+(a_{34}^{''})^{(6)}(T_{33},t)} \boxed{+(a_{30}^{''})^{(5,5,5)}(T_{29},t)} \boxed{+(a_{26}^{''})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{34} \quad 87$$

$\boxed{+(a_{32}^{''})^{(6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{28}^{''})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{24}^{''})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[\begin{matrix} (b_{32}^{'})^{(6)} \boxed{-(b_{32}^{''})^{(6)}(G_{35},t)} \boxed{-(b_{28}^{''})^{(5,5,5)}(G_{31},t)} \boxed{-(b_{24}^{''})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}^{''})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[\begin{matrix} (b_{33}^{'})^{(6)} \boxed{-(b_{33}^{''})^{(6)}(G_{35},t)} \boxed{-(b_{29}^{''})^{(5,5,5)}(G_{31},t)} \boxed{-(b_{25}^{''})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}^{''})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[\begin{matrix} (b_{34}^{'})^{(6)} \boxed{-(b_{34}^{''})^{(6)}(G_{35},t)} \boxed{-(b_{30}^{''})^{(5,5,5)}(G_{31},t)} \boxed{-(b_{26}^{''})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}^{''})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{34} \quad 90$$

$\boxed{-(b_{32}^{''})^{(6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{28}^{''})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{24}^{''})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients*

$for\ category$ 1,2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix}(a'_{36})^{(7)}\boxed{+(a''_{36})^{(7)}(T_{37},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix}(a'_{37})^{(7)}\boxed{+(a''_{37})^{(7)}(T_{37},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{14}$	92
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix}(a'_{38})^{(7)}\boxed{+(a''_{38})^{(7)}(T_{37},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{15}$	93
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation	

coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \; \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \; \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \; \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \; \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \; \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \; \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13} \quad (94)$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \; \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \; \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \; \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \; \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \; \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \; \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \; \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \; \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \; \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \; \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \; \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \; \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13}$$ 96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$\frac{dT_{44}}{dt} =$
$(b_{44})^{(9)}T_{45} -$

$$\left[\begin{matrix} (b_{44}^{'})^{(9)} \boxed{-(b_{44}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[\begin{matrix} (b_{45}^{'})^{(9)} \boxed{-(b_{45}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[\begin{matrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3

Where we suppose

$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i, j = 13,14,15$ 97

The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded.

<u>**Definition of**</u> $(p_i)^{(1)}, \ (r_i)^{(1)}$:

$(a_i'')^{(1)}(T_{14},t) \le (p_i)^{(1)} \le (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \le (r_i)^{(1)} \le (b_i')^{(1)} \le (\hat{B}_{13})^{(1)}$	
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \le (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	

$(a_i^{''})^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i^{'})^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty} (a_i^{''})^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty} (b_i^{''})^{(2)}((G_{19}),t) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(2)}(T_{17}^{'},t) - (a_i^{''})^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}^{'}\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i^{''})^{(2)}((G_{19})^{'},t) - (b_i^{''})^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19}) - (G_{19})^{'}\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'},t)$ and$(a_i^{''})^{(2)}(T_{17},t)$. $(T_{17}^{'},t)$ and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i^{''})^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i^{'})^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i^{'})^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$	112

The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (r_i)^{(3)}$: $(a_i^{''})^{(3)}(T_{21},t) \le (p_i)^{(3)} \le (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23},t) \le \ (r_i)^{(3)} \le (b_i^{'})^{(3)} \le (\hat{B}_{20})^{(3)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(3)}(T_{21},t) = (p_i)^{(3)}$ $\lim_{G\to\infty}(b_i^{''})^{(3)}(G_{23},t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\|(a_i^{''})^{(3)}(T_{21}^{'},t) - (a_i^{''})^{(3)}(T_{21},t)\| \le (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}^{'}\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i^{''})^{(3)}(G_{23}{}^{'},t) - (b_i^{''})^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}{}^{'}\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'},t)$ and $(a_i^{''})^{(3)}(T_{21},t)$. $(T_{21}^{'},t)$ And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded.	117

Definition of $(p_i)^{(4)}$, $(r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i^{''})^{(4)}((G_{27}),t) = (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i^{'})^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i^{'})^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded.	122

Definition of $(p_i)^{(5)}, \ (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}),t) \leq \ (r_i)^{(5)} \leq (b_i')^{(5)} \leq (\hat{B}_{28})^{(5)}$	
$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t) = \ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t) - (a_i'')^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t) - (b_i'')^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and $(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}} \ , \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and \ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)} + (a_i')^{(5)} + \ (\hat{A}_{28})^{(5)} + \ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)} + (b_i')^{(5)} + \ (\hat{B}_{28})^{(5)} + \ (\hat{Q}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$	127

The functions $(a_i^{''})^{(6)}, (b_i^{''})^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, \ (r_i)^{(6)}$: $(a_i^{''})^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i^{''})^{(6)}((G_{35}),t) \leq \ (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2 \to \infty} (a_i^{''})^{(6)}(T_{33},t) = (p_i)^{(6)}$ $\lim_{G \to \infty} (b_i^{''})^{(6)}\left((G_{35}),t\right) = \ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(6)}(T_{33}^{'},t) - (a_i^{''})^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)}\lvert T_{33} - T_{33}^{'}\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i^{''})^{(6)}((G_{35})^{'},t) - (b_i^{''})^{(6)}\left((G_{35}),t\right)\rvert < (\hat{k}_{32})^{(6)}\lvert\lvert(G_{35}) - (G_{35})^{'}\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'},t)$ and $(a_i^{''})^{(6)}(T_{33},t)$. $(T_{33}^{'},t)$ and (T_{33},t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i^{'})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i^{'})^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)}\ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i^{'})^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)}\ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	

(WWWWW) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (XXXXX) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39}, t) \leq \ (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(YYYYY) $\lim_{T_2 \to \infty} (a_i^{''})^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(ZZZZZ)* $\lim_{G \to \infty} (b_i^{''})^{(7)} \left((G_{39}), t\right) = \ (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\|(a_i^{''})^{(7)}(T_{37}^{'}, t) - (a_i^{''})^{(7)}(T_{37}, t)\| \leq (\hat{k}_{36})^{(7)}\|T_{37} - T_{37}^{'}\|e^{-(\hat{M}_{36})^{(7)}t}$ $\|(b_i^{''})^{(7)}((G_{39})^{'}, t) - (b_i^{''})^{(7)}\left((G_{39}), t\right)\| < (\hat{k}_{36})^{(7)}\|\|(G_{39}) - (G_{39})^{'}\|\|e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'}, t)$ and $(a_i^{''})^{(7)}(T_{37}, t)$. $(T_{37}^{'}, t)$ and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (AAAAAA) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (BBBBBB) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and\ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[\ (a_i)^{(7)} + (a_i^{'})^{(7)} + \ (\hat{A}_{36})^{(7)} + \ (\hat{P}_{36})^{(7)} \ (\hat{k}_{36})^{(7)}] < 1$	135

$\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)}+(b_i')^{(7)}+(\hat{B}_{36})^{(7)}+(\hat{Q}_{36})^{(7)}(\hat{k}_{36})^{(7)}]<1$	
Where we suppose	
$(a_i)^{(8)},(a_i')^{(8)},(a_i'')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(b_i'')^{(8)}>0, \quad i,j=40,41,42$	136
The functions $(a_i'')^{(8)},(b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41},t)\le(p_i)^{(8)}\le(\hat{A}_{40})^{(8)}$	138
$(b_i'')^{(8)}((G_{43}),t)\le (r_i)^{(8)}\le(b_i')^{(8)}\le(\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i'')^{(8)}(T_{41},t)=(p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i'')^{(8)}\left((G_{43}),t\right)= (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)},(\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)},(\hat{B}_{40})^{(8)},(p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i=40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t)-(a_i'')^{(8)}(T_{41},t)\rvert\le(\hat{k}_{40})^{(8)}\lvert T_{41}-T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})',t)-(b_i'')^{(8)}\left((G_{43}),t\right)\rvert<(\hat{k}_{40})^{(8)}\lvert\lvert(G_{43})-(G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)}=1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}<1$	144
Definition of $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)}, (r_i)^{(8)}, i=40,41,42,$	

Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i^{'})^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i^{'})^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i^{'})^{(9)}, (a_i^{''})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (b_i^{''})^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty} (a_i^{''})^{(9)}(T_{45},t) = (p_i)^{(9)}$ $\lim_{G\to\infty} (b_i^{''})^{(9)}(G_{47},t) = (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i = 44,45,46$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t)\rvert \leq (\hat{k}_{44})^{(9)}\lvert T_{45} - T_{45}^{'}\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}((G_{47}),t)\rvert < (\hat{k}_{44})^{(9)}\lvert\lvert(G_{47}) - (G_{47})^{'}\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with	

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities $$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$ $$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions	152

Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	

$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{16})^{(2)}, T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{20}(s_{(20)}) \right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{22}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{20}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{22}(s_{(20)}) \right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{24})^{(4)}, T_i^0 \le (\hat{Q}_{24})^{(4)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to$	

$\mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{28})^{(5)} ,T_i^0 \leq (\hat{Q}_{28})^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{28}')^{(5)} + a_{28}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{28}\left(s_{(28)}\right)\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}\left(s_{(28)}\right) - \left((a_{29}')^{(5)} + (a_{29}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{29}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{30}')^{(5)} + (a_{30}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{30}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{28}')^{(5)} - (b_{28}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{28}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}\left(s_{(28)}\right) - \left((b_{29}')^{(5)} - (b_{29}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{29}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{30}')^{(5)} - (b_{30}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{30}\left(s_{(28)}\right)\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i , T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{32})^{(6)} ,T_i^0 \leq (\hat{Q}_{32})^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}\left(s_{(32)}\right) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{32}\left(s_{(32)}\right)\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}\left(s_{(32)}\right) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{33}\left(s_{(32)}\right)\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}\left(s_{(32)}\right) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{34}\left(s_{(32)}\right)\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}\left(s_{(32)}\right) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}\left(G_{35}\left(s_{(32)}\right), s_{(32)}\right)\right) T_{32}\left(s_{(32)}\right)\right] ds_{(32)}$	

$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)} \left(G_{35}(s_{(32)}), s_{(32)} \right) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{36})^{(7)}, T_i^0 \le (\hat{Q}_{36})^{(7)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{40})^{(8)}, T_i^0 \le (\hat{Q}_{40})^{(8)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a'_{44})^{(9)} + a''_{44})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	

The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[((\hat{P}_{13})^{(1)} + G_{14}^0) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[((\hat{P}_{16})^{(2)} + G_{17}^0) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1\right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[((\hat{P}_{20})^{(3)} + G_{21}^0) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0}\right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}}\right)\right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1\right)$	173

From which it follows that $(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0+\int_0^t\left[(a_{28})^{(5)}\left(G_{29}^0+(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\right)\right]ds_{(28)}=$ $\left(1+(a_{28})^{(5)}t\right)G_{29}^0+\frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t}-1\right)$	
From which it follows that $(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{P}_{28})^{(5)}+G_{29}^0\right)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)}+(\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0+\int_0^t\left[(a_{32})^{(6)}\left(G_{33}^0+(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}s_{(32)}}\right)\right]ds_{(32)}=$ $\left(1+(a_{32})^{(6)}t\right)G_{33}^0+\frac{(a_{32})^{(6)}(\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left(e^{(\hat{M}_{32})^{(6)}t}-1\right)$	176
From which it follows that $(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for G_{25} ,G_{26},T_{24},T_{25},T_{26}	177
(v) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0+\int_0^t\left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right]ds_{(36)}=$ $\left(1+(a_{36})^{(7)}t\right)G_{37}^0+\frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$	178
From which it follows that	

$(G_{36}(t) - G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)}\left(G_{41}^0 + (\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right] ds_{(40)} =$ $\left(1 + (a_{40})^{(8)}t\right)G_{41}^0 + \frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t} - 1\right)$	180
From which it follows that $(G_{40}(t) - G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)} + G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)} + (\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0 + \int_0^t \left[(a_{44})^{(9)}\left(G_{45}^0 + (\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right] ds_{(44)} =$ $\left(1 + (a_{44})^{(9)}t\right)G_{45}^0 + \frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t} - 1\right)$	
From which it follows that $(G_{44}(t) - G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)} + G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)} + (\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for $G_{45}, G_{46}, T_{44}, T_{45}, T_{46}$	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)} + \left((\hat{P}_{13})^{(1)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{Q}_{13})^{(1)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{13})^{(1)}\right] \leq (\hat{Q}_{13})^{(1)}$	184
In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	

The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left(\left(G^{(1)},T^{(1)}\right),\left(G^{(2)},T^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{13})^{(1)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{13})^{(1)}t}\}$	185
Indeed if we denote **Definition of** $\tilde{G},\tilde{T}$: $(\tilde{G},\tilde{T}) = \mathcal{A}^{(1)}(G,T)$ It results $\lvert\tilde{G}_{13}^{(1)}-\tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{13})^{(1)} \lvert G_{14}^{(1)}-G_{14}^{(2)}\rvert e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}}\, ds_{(13)} +$ $\int_0^t \{(a'_{13})^{(1)} \lvert G_{13}^{(1)}-G_{13}^{(2)}\rvert e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{-(\hat{M}_{13})^{(1)}s_{(13)}} +$ $(a''_{13})^{(1)}(T_{14}^{(1)},s_{(13)}) \lvert G_{13}^{(1)}-G_{13}^{(2)}\rvert e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}} +$ $G_{13}^{(2)} \lvert (a''_{13})^{(1)}(T_{14}^{(1)},s_{(13)}) - (a''_{13})^{(1)}(T_{14}^{(2)},s_{(13)}) \rvert\ e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}}\} ds_{(13)}$ Where $s_{(13)}$ represents integrand that is integrated over the interval [0, t] From the hypotheses it follows	
$\lvert G^{(1)}-G^{(2)}\rvert e^{-(\hat{M}_{13})^{(1)}t} \leq$ $\frac{1}{(\hat{M}_{13})^{(1)}}\left((a_{13})^{(1)} + (a'_{13})^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}\right) d\left(\left(G^{(1)},T^{(1)};\ G^{(2)},T^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	186
Remark 1: The fact that we supposed $(a''_{13})^{(1)}$ and $(b''_{13})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$ *and* $(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(1)}$ and $(b''_i)^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on G(*and not on t*) and hypothesis can replaced by a usual Lipschitz condition.	
Remark 2: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ From 19 to 24 it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(1)} - (a''_i)^{(1)}(T_{14}(s_{(13)}),s_{(13)})\} ds_{(13)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b'_i)^{(1)}t)} > 0$ for t > 0	

Definition of $\left((\widehat{M}_{13})^{(1)}\right)_1, \left((\widehat{M}_{13})^{(1)}\right)_2$ *and* $\left((\widehat{M}_{13})^{(1)}\right)_3$: 187

Remark 3: if G_{13} is bounded, the same property have also G_{14} *and* G_{15} . indeed if

$G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \le \left((\widehat{M}_{13})^{(1)}\right)_1 - (a_{14}^{'})^{(1)} G_{14}$ and by integrating

$G_{14} \le \left((\widehat{M}_{13})^{(1)}\right)_2 = G_{14}^0 + 2(a_{14})^{(1)} \left((\widehat{M}_{13})^{(1)}\right)_1 / (a_{14}^{'})^{(1)}$

In the same way , one can obtain

$G_{15} \le \left((\widehat{M}_{13})^{(1)}\right)_3 = G_{15}^0 + 2(a_{15})^{(1)} \left((\widehat{M}_{13})^{(1)}\right)_2 / (a_{15}^{'})^{(1)}$

If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.

Remark 4: If G_{13} *is* bounded, from below, the same property holds for G_{14} *and* G_{15} . The proof is analogous with the preceding one. An analogous property is true if G_{14} is bounded from below. 188

Remark 5: If T_{13} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(1)}(G(t),t)) = (b_{14}^{'})^{(1)}$ then $T_{14} \to \infty$. 189

Definition of $(m)^{(1)}$ and ε_1 :

Indeed let t_1 be so that for $t > t_1$

$(b_{14})^{(1)} - (b_i^{''})^{(1)}(G(t),t) < \varepsilon_1, T_{13}(t) > (m)^{(1)}$

Then $\frac{dT_{14}}{dt} \ge (a_{14})^{(1)}(m)^{(1)} - \varepsilon_1 T_{14}$ which leads to

$T_{14} \ge \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{\varepsilon_1}\right)(1 - e^{-\varepsilon_1 t}) + T_{14}^0 e^{-\varepsilon_1 t}$ If we take t such that $e^{-\varepsilon_1 t} = \frac{1}{2}$ it results

$T_{14} \ge \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{2}\right), \quad t = log\frac{2}{\varepsilon_1}$ By taking now ε_1 sufficiently small one sees that T_{14} is unbounded. The same property holds for T_{15} if $\lim_{t\to\infty}(b_{15}^{''})^{(1)}(G(t),t) = (b_{15}^{'})^{(1)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations

It is now sufficient to take $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$ and to choose 190

$(\hat{P}_{16})^{(2)}$ *and* $(\hat{Q}_{16})^{(2)}$ large to have

$$\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[(\hat{P}_{16})^{(2)} + \left((\hat{P}_{16})^{(2)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{16})^{(2)}+G_j^0}{G_j^0}\right)}\right] \le (\hat{P}_{16})^{(2)} \quad 191$$

$$\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{Q}_{16})^{(2)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{16})^{(2)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{16})^{(2)}\right] \le (\hat{Q}_{16})^{(2)} \quad 192$$

In order that the operator $\mathcal{A}^{(2)}$ transforms the space of sextuples of functions G_i, T_i satisfying 193

Equations into itself	
The operator $\mathcal{A}^{(2)}$ is a contraction with respect to the metric $d\left(\left((G_{19})^{(1)},(T_{19})^{(1)}\right),\left((G_{19})^{(2)},(T_{19})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\widehat{M}_{16})^{(2)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\widehat{M}_{16})^{(2)}t}\}$	194
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And analogous inequalities for G_i and T_i. Taking into account the hypothesis the result follows	198
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<u>Remark 7:</u> There does not exist any t where $G_i(t)=0$ and $T_i(t)=0$ it results $G_i(t)\geq G_i^0e^{\left[-\int_0^t\{(a_i')^{(2)}-(a_i'')^{(2)}(T_{17}(s_{(16)}),s_{(16)})\}ds_{(16)}\right]}\geq 0$	200

$T_i(t) \geq T_i^0 e^{(-(b_i')^{(2)} t)} > 0 \quad \text{for } t > 0$	
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$\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}}\left[((\hat{Q}_{20})^{(3)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{20})^{(3)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{20})^{(3)}\right] \leq (\hat{Q}_{20})^{(3)}$	209

In order that the operator $\mathcal{A}^{(3)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	210
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Indeed if we denote **Definition of** $\widetilde{G_{23}},\widetilde{T_{23}}$:$\left(\widetilde{(G_{23})},\widetilde{(T_{23})}\right)=\mathcal{A}^{(3)}\left((G_{23}),(T_{23})\right)$	212
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$T_i(t) \geq T_i^0 e^{(-(b_i')^{(3)}t)} > 0$ for $t > 0$	
Definition of $\left((\widehat{M}_{20})^{(3)}\right)_1, \left((\widehat{M}_{20})^{(3)}\right)_2$ *and* $\left((\widehat{M}_{20})^{(3)}\right)_3$: **Remark 13:** if G_{20} is bounded, the same property have also G_{21} *and* G_{22} . indeed if $G_{20} < (\widehat{M}_{20})^{(3)}$ it follows $\frac{dG_{21}}{dt} \leq \left((\widehat{M}_{20})^{(3)}\right)_1 - (a_{21}')^{(3)} G_{21}$ and by integrating $G_{21} \leq \left((\widehat{M}_{20})^{(3)}\right)_2 = G_{21}^0 + 2(a_{21})^{(3)} \left((\widehat{M}_{20})^{(3)}\right)_1 / (a_{21}')^{(3)}$ In the same way , one can obtain $G_{22} \leq \left((\widehat{M}_{20})^{(3)}\right)_3 = G_{22}^0 + 2(a_{22})^{(3)} \left((\widehat{M}_{20})^{(3)}\right)_2 / (a_{22}')^{(3)}$ If G_{21} *or* G_{22} is bounded, the same property follows for G_{20} , G_{22} and G_{20} , G_{21} respectively.	217
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In order that the operator $\mathcal{A}^{(4)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	224
The operator $\mathcal{A}^{(4)}$ is a contraction with respect to the metric $d\left(\left((G_{27})^{(1)},(T_{27})^{(1)}\right),\left((G_{27})^{(2)},(T_{27})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{24})^{(4)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{24})^{(4)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{27})},\widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})},\widetilde{(T_{27})}\right)=\mathcal{A}^{(4)}((G_{27}),(T_{27}))$ It results $\left\|\tilde{G}_{24}^{(1)}-\tilde{G}_i^{(2)}\right\|\leq\int_0^t(a_{24})^{(4)}\left\|G_{25}^{(1)}-G_{25}^{(2)}\right\|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\,ds_{(24)}+$ $\int_0^t\{(a_{24}')^{(4)}\left\|G_{24}^{(1)}-G_{24}^{(2)}\right\|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{-(\hat{M}_{24})^{(4)}s_{(24)}}+$ $(a_{24}'')^{(4)}\left(T_{25}^{(1)},s_{(24)}\right)\left\|G_{24}^{(1)}-G_{24}^{(2)}\right\|e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}+$ $G_{24}^{(2)}\|(a_{24}'')^{(4)}\left(T_{25}^{(1)},s_{(24)}\right)-(a_{24}'')^{(4)}\left(T_{25}^{(2)},s_{(24)}\right)\|\ e^{-(\hat{M}_{24})^{(4)}s_{(24)}}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\}ds_{(24)}$ Where $s_{(24)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on Equations it follows	225
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$T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(4)} t)} > 0 \quad \text{for } t > 0$	
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Remark 37 There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)} - (a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for t > 0	275
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Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}((G_{43})(t),t) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results	279

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right)$, $t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b''_{42})^{(8)}\left((G_{43})(t), t(t), t\right) = (b'_{42})^{(8)}$

It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)},(T_{47})^{(1)}\right),\left((G_{47})^{(2)},(T_{47})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}), (T_{47})\right)$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t\{(a'_{44})^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)|\; e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ From 99 to 44 it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)}t)} > 0$ for t > 0	
Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$: **Remark 43:** if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if $G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating $G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$ In the same way , one can obtain $G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$ If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.	
Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.	
Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t), t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t), t) = (b_{46}')^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a'_{13})^{(1)} + (a'_{14})^{(1)} - (a''_{13})^{(1)}(T_{14}, t) + (a''_{14})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G, t) - (b''_{14})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)}, , (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if \ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$ and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)}, \ if \ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)}, \ if \ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if \ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if \ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t}-e^{-(S_2)^{(1)}t}\right]+G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq$ $\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}^{'})^{(1)})}[e^{(S_1)^{(1)}t}-e^{-(a_{15}^{'})^{(1)}t}]+ G_{15}^0 e^{-(a_{15}^{'})^{(1)}t})$	286
$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}^{'})^{(1)})}\left[e^{(R_1)^{(1)}t}-e^{-(b_{15}^{'})^{(1)}t}\right]+T_{15}^0 e^{-(b_{15}^{'})^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t}-e^{-(R_2)^{(1)}t}\right]+T_{15}^0 e^{-(R_2)^{(1)}t}$	289
<u>**Definition of**</u> $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}^{'})^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}^{'})^{(1)}$ $(R_2)^{(1)} = (b_{15}^{'})^{(1)} - (r_{15})^{(1)}$	290
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define	291
<u>**Definition of**</u> $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}((G_{19}), t) - (b_{17}^{''})^{(2)}((G_{19}), t) \leq -(\tau_1)^{(2)}$	294
<u>**Definition of**</u> $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}(u^{(2)})^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
<u>**Definition of**</u> $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300

roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}, \ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})}\left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$	315

$\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t}-e^{-(R_2)^{(2)}t}\right]+T_{18}^0 e^{-(R_2)^{(2)}t}$	
Definition of $(S_1)^{(2)},(S_2)^{(2)},(R_1)^{(2)},(R_2)^{(2)}$:-	316
Where $(S_1)^{(2)}=(a_{16})^{(2)}(m_2)^{(2)}-(a'_{16})^{(2)}$ $(S_2)^{(2)}=(a_{18})^{(2)}-(p_{18})^{(2)}$	317
$(R_1)^{(2)}=(b_{16})^{(2)}(\mu_2)^{(1)}-(b'_{16})^{(2)}$ $(R_2)^{(2)}=(b'_{18})^{(2)}-(r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)}\le-(a'_{20})^{(3)}+(a'_{21})^{(3)}-(a''_{20})^{(3)}(T_{21},t)+(a''_{21})^{(3)}(T_{21},t)\le-(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)}\le-(b'_{20})^{(3)}+(b'_{21})^{(3)}-(b''_{20})^{(3)}(G_{23},t)-(b''_{21})^{(3)}((G_{23}),t)\le-(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)},(\nu_2)^{(3)},(u_1)^{(3)},(u_2)^{(3)}$: By $(\nu_1)^{(3)}>0,(\nu_2)^{(3)}<0$ and respectively $(u_1)^{(3)}>0,(u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2+(\sigma_1)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}(u^{(3)})^2+(\tau_1)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$ and By $(\bar\nu_1)^{(3)}>0,(\bar\nu_2)^{(3)}<0$ and respectively $(\bar u_1)^{(3)}>0,(\bar u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2+(\sigma_2)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}(u^{(3)})^2+(\tau_2)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$	320
Definition of $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$ by $(m_2)^{(3)}=(\nu_0)^{(3)},(m_1)^{(3)}=(\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)}<(\nu_1)^{(3)}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\bar\nu_1)^{(3)},\boldsymbol{if}\ (\nu_1)^{(3)}<(\nu_0)^{(3)}<(\bar\nu_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)}=\frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar\nu_1)^{(3)}<(\nu_0)^{(3)}$	321

and analogously 322

$(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}$, ***if*** $(u_0)^{(3)} < (u_1)^{(3)}$

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}$, ***if*** $(u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}$, ***if*** $(\bar{u}_1)^{(3)} < (u_0)^{(3)}$

Then the solution of global equations satisfies the inequalities

$G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$

$(p_i)^{(3)}$ is defined by equation

$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$ 323

$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ 324

$\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a'_{22})^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a'_{22})^{(3)}t}\right] + G_{22}^0 e^{-(a'_{22})^{(3)}t}\right)$

$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$ 325

$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$ 326

$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b'_{22})^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b'_{22})^{(3)}t}\right] + T_{22}^0 e^{-(b'_{22})^{(3)}t} \leq T_{22}(t) \leq$ 327

$\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$

<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- 328

Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$

$(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$

$(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$

$(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$

<u>**Behavior of the solutions of equation**</u>

<u>**Theorem:**</u> If we denote and define

<u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$:

$(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying

$-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)},(\nu_2)^{(4)},(u_1)^{(4)},(u_2)^{(4)},\nu^{(4)},u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},,(\bar{\nu}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)},(m_1)^{(4)} = (\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)},(m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, $\boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)},(m_1)^{(4)} = (\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)},(\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)},(\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)},(\mu_1)^{(4)} = (u_0)^{(4)},\boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)},(\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}^{'})^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}^{'})^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}^{'})^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}^{'})^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}^{'})^{(4)}$ $(R_2)^{(4)}=(b_{26}^{'})^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}-(a_{28}^{''})^{(5)}(T_{29},t)+(a_{29}^{''})^{(5)}(T_{29},t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31}),t)-(b_{29}^{''})^{(5)}((G_{31}),t) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},,(\bar{\nu}_2)^{(5)},(\bar{u}_1)^{(5)},(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)}>0,(\bar{\nu}_2)^{(5)}<0$ and respectively $(\bar{u}_1)^{(5)}>0,(\bar{u}_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar{\nu}_1)^{(5)}$,	340

and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ ,\boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} - (a_{32}^{''})^{(6)}(T_{33}, t) + (a_{33}^{''})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b_{32}^{'})^{(6)} + (b_{33}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}), t\right) - (b_{33}^{''})^{(6)}\left((G_{35}), t\right) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \ \boldsymbol{if} \ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \ \boldsymbol{if} \ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if} \ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{\left((S_1)^{(6)} - (p_{32})^{(6)}\right)t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)}G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ (a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)}T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)}T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
<u>**Definition of**</u> $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}\big((G_{39}), t\big) - (b_{37}'')^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
<u>**Definition of**</u> $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
<u>**Definition of**</u> $(\bar{\nu}_1)^{(7)}, , (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the	362

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2+(\sigma_2)^{(7)}\nu^{(7)}-(a_{36})^{(7)}=0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2+(\tau_2)^{(7)}u^{(7)}-(b_{36})^{(7)}=0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)}=(\nu_0)^{(7)}, (m_1)^{(7)}=(\nu_1)^{(7)}, \; \boldsymbol{if} \; (\nu_0)^{(7)}<(\nu_1)^{(7)}$ $(m_2)^{(7)}=(\nu_1)^{(7)}, (m_1)^{(7)}=(\bar{\nu}_1)^{(7)}, \boldsymbol{if} \; (\nu_1)^{(7)}<(\nu_0)^{(7)}<(\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)}=(\nu_1)^{(7)}, (m_1)^{(7)}=(\nu_0)^{(7)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(7)}<(\nu_0)^{(7)}$	
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$$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$$

$$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \le -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \le -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \le -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \le -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14}, t) \right) - (a_{14}'')^{(1)}(T_{14}, t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)} \left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} \right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)} \left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} \right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a_{13}^{''})^{(1)} = (a_{14}^{''})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b_{13}^{''})^{(1)} = (b_{14}^{''})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a_{16}^{'})^{(2)} - (a_{17}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right) - (a_{17}^{''})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}$, $\boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390
In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$	391
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If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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In a completely analogous way, we obtain <u>Definition of</u> $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}, \quad \boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
<u>Particular case :</u> If $(a_{16}'')^{(2)} = (a_{17}'')^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b_{16}'')^{(2)} = (b_{17}'')^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
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<u>Definition of</u> $\nu^{(3)}$:- $\quad \boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$$

Definition of $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{20}'')^{(3)} = (a_{21}'')^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b_{20}'')^{(3)} = (b_{21}'')^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
Proof : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a_{24}')^{(4)} - (a_{25}')^{(4)} + (a_{24}'')^{(4)}(T_{25}, t)\right) - (a_{25}'')^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **Definition of** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	405
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$**.**

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:- For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$	
In the same manner , we get $\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$	413
If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$ $\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$	414
If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(6)}(t)$:- $(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)},\ \boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(6)}(t)$:- $(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)},\ \boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	415

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	424

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Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

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In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

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If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

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If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain $(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(9)}(t)$:- $(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(9)}(t)$:- $(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$ Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem. **Particular case :** If $(a_{44}^{''})^{(9)} = (a_{45}^{''})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case** . Analogously if $(b_{44}^{''})^{(9)} = (b_{45}^{''})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.	
We can prove the following **Theorem** : If $(a_i^{''})^{(1)} and\ (b_i^{''})^{(1)}$ are independent on t , and the conditions with the notations $(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$ $(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}^{'})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$ $(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}^{'})^{(1)}(r_{14})^{(1)} - (b_{14}^{'})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ *with* $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	425
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429

$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-(b_{16}^{'})^{(2)}(r_{17})^{(2)}-(b_{17}^{'})^{(2)}(r_{17})^{(2)}+(r_{16})^{(2)}(r_{17})^{(2)}<0$ $with\ (p_{16})^{(2)},(r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}<0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}+(a_{20})^{(3)}(p_{20})^{(3)}+(a_{21}^{'})^{(3)}(p_{21})^{(3)}+(p_{20})^{(3)}(p_{21})^{(3)}>0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}>0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-(b_{20}^{'})^{(3)}(r_{21})^{(3)}-(b_{21}^{'})^{(3)}(r_{21})^{(3)}+(r_{20})^{(3)}(r_{21})^{(3)}<0$ $with\ (p_{20})^{(3)},(r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}<0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}+(a_{24})^{(4)}(p_{24})^{(4)}+(a_{25}^{'})^{(4)}(p_{25})^{(4)}+(p_{24})^{(4)}(p_{25})^{(4)}>0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}>0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-(b_{24}^{'})^{(4)}(r_{25})^{(4)}-(b_{25}^{'})^{(4)}(r_{25})^{(4)}+(r_{24})^{(4)}(r_{25})^{(4)}<0$ $with\ (p_{24})^{(4)},(r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}<0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}+(a_{28})^{(5)}(p_{28})^{(5)}+(a_{29}^{'})^{(5)}(p_{29})^{(5)}+(p_{28})^{(5)}(p_{29})^{(5)}>0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}>0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-(b_{28}^{'})^{(5)}(r_{29})^{(5)}-(b_{29}^{'})^{(5)}(r_{29})^{(5)}+(r_{28})^{(5)}(r_{29})^{(5)}<0$ $with\ (p_{28})^{(5)},(r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}<0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}+(a_{32})^{(6)}(p_{32})^{(6)}+(a_{33}^{'})^{(6)}(p_{33})^{(6)}+(p_{32})^{(6)}(p_{33})^{(6)}>0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}>0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-(b_{32}^{'})^{(6)}(r_{33})^{(6)}-(b_{33}^{'})^{(6)}(r_{33})^{(6)}+(r_{32})^{(6)}(r_{33})^{(6)}<0$	434

with $(p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ *with* $(p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ *with* $(p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ *with* $(p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}')^{(5)} - (b_{28}'')^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}')^{(5)} - (b_{29}'')^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}')^{(5)} - (b_{30}'')^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}')^{(6)} - (b_{32}'')^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}')^{(6)} - (b_{33}'')^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}')^{(6)} - (b_{34}'')^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}')^{(7)} - (b_{36}'')^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}')^{(7)} - (b_{37}'')^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}')^{(7)} - (b_{38}'')^{(7)}(G_{39})\,]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (v) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	499
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*})=0$. With this value , we obtain from the three first equations $G_{40}=\frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42}=\frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*})=0$. With this value , we obtain from the three first equations $G_{44}=\frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46}=\frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G)=(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)}-(b_{13})^{(1)}(b_{14})^{(1)}-$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G)+(b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right]+(b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G)=0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*})=0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19})=(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19})+(b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right]+(b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19})=0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23})=(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23})+(b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26})$, G_{24}, G_{26} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{25} such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30})$, G_{28}, G_{30} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{29} such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34})$, G_{32}, G_{34} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{33} such that $\varphi({G_{35}}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38})$, G_{36}, G_{38} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{37} such that $\varphi({G_{39}}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42})$, G_{40}, G_{42} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi({G_{43}}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}')^{(8)} - (b_{40}'')^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}')^{(8)} - (b_{42}'')^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_{j}\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_{j}\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_{j}\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*}) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_{j}\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_{j}\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_{j}\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}'')^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i'')^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}')^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}')^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}')^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}')^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}')^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}')^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(5)}$ *and* $(b_i'')^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}'')^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i'')^{(5)}}{\partial G_j}(\ (G_{31})^*\ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}((G_{35})^*) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}((G_{39})^{**}) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** __**Theorem 8:**__ If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
__**Definition of**__ $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b''_i)^{(8)}}{\partial G_j}(\,(G_{43})^*\,) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^*\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^*\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^*\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS __**Theorem 9:**__ If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(9)}$ *and* $(b''_i)^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$ $$\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i'')^{(9)}}{\partial G_j}(\,(G_{47})^*\,) = s_{ij}$$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^*\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^*\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^*\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^*\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^*\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^*\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}')^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^* + (b_{14})^{(1)}s_{(13),(13)}T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$ $+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$ +	

$$\left((\lambda)^{(2)}+(b_{18}')^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}')^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}')^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}')^{(2)}+(b_{17}')^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(3)}+(b_{22}')^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}')^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$$

$$+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$$

+

$((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(((\lambda)^{(4)})^{2}+((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^{2}+((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)})(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^{2}+((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)})s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(((\lambda)^{(5)})^{2}+((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^{2}+((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)})(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^{2}+((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)})s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$ +	

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$((\lambda)^{(8)} + (b'_{42})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a'_{42})^{(8)} + (p_{42})^{(8)})$

$\left[\left(((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(q_{40})^{(8)}G^*_{40}\right)\right]$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T^*_{41} + (b_{41})^{(8)}s_{(40),(41)}T^*_{41}\right)$

$+\left(((\lambda)^{(8)} + (a'_{41})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G^*_{40} + (a_{40})^{(8)}(q_{41})^{(8)}G^*_{41}\right)$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T^*_{41} + (b_{41})^{(8)}s_{(40),(40)}T^*_{40}\right)$

$\left(((\lambda)^{(8)})^2 + ((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})(\lambda)^{(8)}\right)$

$\left(((\lambda)^{(8)})^2 + ((b'_{40})^{(8)} + (b'_{41})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)})(\lambda)^{(8)}\right)$

$+\left(((\lambda)^{(8)})^2 + ((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G^*_{40}\right)$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T^*_{41} + (b_{41})^{(8)}s_{(40),(42)}T^*_{40}\right)\} = 0$

$+$

$((\lambda)^{(9)} + (b'_{46})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a'_{46})^{(9)} + (p_{46})^{(9)})$

$\left[\left(((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(q_{44})^{(9)}G^*_{44}\right)\right]$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T^*_{45} + (b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$

$+\left(((\lambda)^{(9)} + (a'_{45})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G^*_{44} + (a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T^*_{45} + (b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$

$\left(((\lambda)^{(9)})^2 + ((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})(\lambda)^{(9)}\right)$

$\left(((\lambda)^{(9)})^2 + ((b'_{44})^{(9)} + (b'_{45})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)})(\lambda)^{(9)}\right)$

$+\left(((\lambda)^{(9)})^2 + ((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T^*_{45} + (b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\} = 0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.	
Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.	

SECTION TWENTY THREE

Deformations Of The Spin Currents By Topological Screw Dislocation And Cosmic Dispiration

INTRODUCTION—VARIABLES USED

Deformations of the spin currents by topological screw dislocation and cosmic dispiration Jian-Hua Wang, Kai Ma, Kang Li, Hua-wei Fan

(1) For the topological screw dislocation, only the direction of spin current is bended by (e&eb) deforming the spin polarization vector.

(2) In contrast, the force induced by (e) cosmic dispiration could affect both (e&eb) the direction and magnitude of the spin current.

(3) As a consequence, the spin-Hall conductivity doesn't (e) receive corrections from screw dislocation. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); General Relativity and Quantum Cosmology (gr-qc); Quantum Physics (quant-ph) Journal reference: Ann. Phys. 362, 327(2015) DOI: 10.1016/j.aop.2015.08.004 Cite as: arXiv: 1510.07741 [cond-mat.mes-hall] (or arXiv:1510.07741v1 [cond-mat.mes-hall] for this version

NOTATION

Module One

By using the extended Drude model, authors find that the spin dependent forces are modified by (e&eb) the nontrivial geometry

G_{13} : Category one of **spin dependent forces;** nontrivial geometry

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of nontrivial geometry **;spin dependent forces**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

In contrast, the force induced by (e) cosmic dispiration could affect both (e&eb) the direction and magnitude of the spin current

G_{16} : Category one of force induced; **cosmic dispiration** G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of **cosmic dispiration;** force induced T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three In contrast, the force induced by cosmic dispiration could affect both (e&eb) the direction and magnitude of the spin current	
G_{20} : Category one of **force induced by cosmic dispiration;** direction and magnitude of the spin current G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of direction and magnitude of the spin current; **force induced by cosmic dispiration** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four As a consequence, the spin-Hall conductivity doesn't (e) receive corrections from screw dislocation. Subjects: Mesoscale and Nanoscale Physics (cond-mat.mes-hall); General Relativity and Quantum Cosmology (gr-qc); Quantum Physics (quant-ph) Journal reference: Ann. Phys. 362, 327(2015) DOI: 10.1016/j.aop.2015.08.004 Cite as: arXiv: 1510.07741 [cond-mat.mes-hall] (or arXiv:1510.07741v1 [cond-mat.mes-hall] for this version	
G_{24} : Category one of **spin-Hall conductivity;** reception of corrections from screw dislocation G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of reception of corrections from screw dislocation **;spin-Hall conductivity** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five **Renormalized scalar propagator around a dispiration V. A. De Lorenci and E. S. Moreira Jr. Phys. Rev. D 67, 124002 – Published 2 June 2003** (1) The renormalized Feynman propagator for a scalar field in the background of (e) a cosmic dispiration (a disclination plus a screw dislocation) is derived, opening a window to investigate	

vacuum polarization effects around (e&eb) a cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration. (2) The use of the propagator is illustrated by (e) computing vacuum fluctuations. (3) In particular it is shown that the dispiration polarizes the vacuum giving rise to (eb) an energy momentum tensor which, as seen from (e) a local inertial frame, presents (eb) nonvanishing off-diagonal components. (4) Such a new effect resembles that where an induced vacuum current arises around (e&eb) a needle solenoid carrying (e&eb) a magnetic flux (the Aharonov-Bohm effect), and may have (e) physical consequences. (5) Connections with a closely related background, namely the spacetime of (e) a spinning cosmic string, are briefly addressed. Received 23 January 2003 DOI: http://dx.doi.org/10.1103/PhysRevD.67.124002 The renormalized Feynman propagator for a scalar field in the background of (e) a cosmic dispiration (a disclination plus a screw dislocation) is derived, opening a window to investigate vacuum polarization effects around (e&eb) a cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration	
G_{28} : Category one of **renormalized Feynman propagator for a scalar field in the background;** a cosmic dispiration (a disclination plus a screw dislocation) is derived, opening a window to investigate vacuum polarization effects around (e&eb) a cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one ofa cosmic dispiration (a disclination plus a screw dislocation) is derived, opening a window to investigate vacuum polarization effects around (e&eb) a cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration; **renormalized Feynman propagator for a scalar field in the background** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six The renormalized Feynman propagator for a scalar field in the background of a cosmic dispiration (a disclination plus a screw dislocation) is derived, opening a window to investigate vacuum polarization effects around (e&eb) a cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration	
G_{32} : Category one of renormalized Feynman propagator for a scalar field in the background of a cosmic dispiration (a disclination plus a screw dislocation) G_{33} : Category two of SAS G_{34} : Category three of SAS	

T_{32} : Category one of vacuum polarization effects around (e&eb) a cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven vacuum polarization effects around (e&eb) a cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration	
G_{36} : Category one of **vacuum polarization effects;** cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of cosmic string with dislocation, as well as in the bulk of (e) an elastic solid carrying (e&eb) a dispiration **;vacuum polarization effects** T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight **vacuum polarization effects around a cosmic string with dislocation, as well as in the bulk of (e) an elastic solid** carrying (e&eb) a dispiration	
G_{40} : Category one of **vacuum polarization effects around a cosmic string with dislocation, as well as in the bulk of an elastic solid;** dispiration G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of dispiration **;vacuum polarization effects around a cosmic string with dislocation, as well as in the bulk of an elastic solid** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine In particular it is shown that the dispiration polarizes the vacuum giving rise to (eb) an energy momentum tensor which, as seen from (e) a local inertial frame, presents (eb) nonvanishing off-diagonal components	
G_{44} : Category one of **dispiration polarizes the vacuum;** energy momentum tensor which, as seen from (e) a local inertial frame, presents (eb) nonvanishing off-diagonal components	

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of energy momentum tensor which, as seen from (e) a local inertial frame, presents (eb) nonvanishing off-diagonal components; **dispiration polarizes the vacuum**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:

$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$:
$(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$
$(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$,
$(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$
$(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$
$(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$
$(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$

are Accentuation coefficients
$(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$
, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$
$(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$,
$(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$
$(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$,
$(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$,
$(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$,
are Dissipation coefficients

Module Numbered One

The differential system of this model is now (Module Numbered one)

$$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right]G_{13} \quad 1$$

$$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t)\right]G_{14} \quad 2$$

$$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t)\right]G_{15} \quad 3$$

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t)\right]T_{13} \quad 4$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t)\right]T_{14} \quad 5$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t)\right]T_{15} \quad 6$$

$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor

$-(b''_{13})^{(1)}(G, t) =$ First detritions factor

Module Numbered Two

The differential system of this model is now (Module numbered two)

$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28

$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}), t\right)\right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}), t\right)\right] T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29}, t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}), t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}, t)\right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}, t)\right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}, t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}), t\right)\right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}), t\right)\right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}), t\right)\right] T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}, t)\right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}, t)\right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}, t)\right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}), t\right)\right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}), t\right)\right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}), t\right)\right] T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}, t)\right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}, t)\right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}, t)\right] G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}), t\right)\right] T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}, t)\right] G_{44}$	49

$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*55*
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	*56*
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	*57*
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

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$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

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Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{16}$$

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$$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$$

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$$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$$

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Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[\begin{matrix}(b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\ \boxed{-(b''_{13})^{(1,1,)}(G,t)}\ \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{16}$$	64
$$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[\begin{matrix}(b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\ \boxed{-(b''_{14})^{(1,1,)}(G,t)}\ \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{17}$$	65
$$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[\begin{matrix}(b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\ \boxed{-(b''_{15})^{(1,1,)}(G,t)}\ \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{18}$$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3	

$-(b_{36}'')^{(7,7,7)}(G_{39},t)$, $-(b_{37}'')^{(7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3 $-(b_{40}'')^{(8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8)}(G_{43},t)$, $-(b_{42}'')^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3 $-(b_{44}'')^{(9,9)}(G_{47},t)$, $-(b_{46}'')^{(9,9)}(G_{47},t)$, $-(b_{45}'')^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t) + (a_{16}'')^{(2,2,2)}(T_{17},t) + (a_{13}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{36}'')^{(7,7,7,7)}(T_{37},t) + (a_{40}'')^{(8,8,8,8)}(T_{41},t) + (a_{44}'')^{(9,9,9)}(T_{45},t) \end{bmatrix} G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21},t) + (a_{17}'')^{(2,2,2)}(T_{17},t) + (a_{14}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{37}'')^{(7,7,7,7)}(T_{37},t) + (a_{41}'')^{(8,8,8,8)}(T_{41},t) + (a_{45}'')^{(9,9,9)}(T_{45},t) \end{bmatrix} G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21},t) + (a_{18}'')^{(2,2,2)}(T_{17},t) + (a_{15}'')^{(1,1,1,)}(T_{14},t) \\ + (a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t) + (a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t) + (a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t) \\ + (a_{38}'')^{(7,7,7,7)}(T_{37},t) + (a_{42}'')^{(8,8,8,8)}(T_{41},t) + (a_{46}'')^{(9,9,9)}(T_{45},t) \end{bmatrix} G_{22}$	69
$+(a_{20}'')^{(3)}(T_{21},t)$, $+(a_{21}'')^{(3)}(T_{21},t)$, $+(a_{22}'')^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a_{16}'')^{(2,2,2)}(T_{17},t)$, $+(a_{17}'')^{(2,2,2)}(T_{17},t)$, $+(a_{18}'')^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3 $+(a_{13}'')^{(1,1,1,)}(T_{14},t)$, $+(a_{14}'')^{(1,1,1,)}(T_{14},t)$, $+(a_{15}'')^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3 $+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a_{36}'')^{(7,7,7,7)}(T_{37},t)$, $+(a_{37}'')^{(7,7,7,7)}(T_{37},t)$, $+(a_{38}'')^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3 $+(a_{40}'')^{(8,8,8,8)}(T_{41},t)$, $+(a_{41}'')^{(8,8,8,8)}(T_{41},t)$, $+(a_{42}'')^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3 $+(a_{44}'')^{(9,9,9)}(T_{45},t)$, $+(a_{45}'')^{(9,9,9)}(T_{45},t)$, $+(a_{46}'')^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23},t) - (b_{16}'')^{(2,2,2)}(G_{19},t) - (b_{13}'')^{(1,1,1,)}(G,t) \\ -(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t) - (b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t) - (b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b_{36}'')^{(7,7,7,7)}(G_{39},t) - (b_{40}'')^{(8,8,8,8)}(G_{43},t) - (b_{44}'')^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{20}$	70

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category$ 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation*

coefficient for category 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$$ 79

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$$ 80

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$$ 81

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$$ 82

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$$	83
$$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$$	85
$$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$$	86
$$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3	

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32}$	*88*
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33}$	*89*
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34}$	*90*
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3	

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)}\boxed{+(a''_{36})^{(7)}(T_{37},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)}\boxed{+(a''_{37})^{(7)}(T_{37},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	92
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix} (a'_{38})^{(7)}\boxed{+(a''_{38})^{(7)}(T_{37},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$	93
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3	

$+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} -(b''_{36})^{(7)}(G_{39},t) -(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t) -(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{13})^{(1,1,1,1,1,1,1)}(G,t) -(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t) -(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} -(b''_{37})^{(7)}(G_{39},t) -(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t) -(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t) -(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t) -(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{14})^{(1,1,1,1,1,1,1)}(G,t) -(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t) -(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} -(b''_{38})^{(7)}(G_{39},t) -(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t) -(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t) -(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t) -(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{15})^{(1,1,1,1,1,1,1)}(G,t) -(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t) -(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{15}$	
Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3 $-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)$, $-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	

$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \begin{bmatrix} (a_{40}^{'})^{(8)} \boxed{+(a_{40}^{''})^{(8)}(T_{41},t)} \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	95
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \begin{bmatrix} (a_{41}^{'})^{(8)} \boxed{+(a_{41}^{''})^{(8)}(T_{41},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \begin{bmatrix} (a_{42}^{'})^{(8)} \boxed{+(a_{42}^{''})^{(8)}(T_{41},t)} \boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	
Where $\boxed{+(a_{40}^{''})^{(8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{40}}{dt} =$	

$$(b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)}\boxed{+(a''_{44})^{(9)}(T_{45},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$(b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{46}}{dt} =$ $(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)},\ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b'_i)^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t) = (r_i)^{(1)}$	98

Definition of $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	
They satisfy Lipschitz condition: $\|(a_i'')^{(1)}(T_{14}', t) - (a_i'')^{(1)}(T_{14}, t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14} - T_{14}'\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b_i'')^{(1)}(G', t) - (b_i'')^{(1)}(G, t)\| < (\hat{k}_{13})^{(1)}\|\|G - G'\|\|e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}', t)$ and $(a_i'')^{(1)}(T_{14}, t)$. (T_{14}', t) and (T_{14}, t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i, j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(\mathrm{p}_i)^{(2)}, (\mathrm{r}_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17}, t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19}, t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2 \to \infty} (a_i'')^{(2)} (T_{17}, t) = (p_i)^{(2)}$	104
$\lim_{G \to \infty} (b_i'')^{(2)} ((G_{19}), t) = (r_i)^{(2)}$	105

Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}}$ are positive constants and $\boxed{i = 16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert (a_i'')^{(2)}(T_{17}', t) - (a_i'')^{(2)}(T_{17}, t) \rvert \leq (\hat{k}_{16})^{(2)} \lvert T_{17} - T_{17}' \rvert e^{-(\hat{M}_{16})^{(2)} t}$	107
$\lvert (b_i'')^{(2)}((G_{19})', t) - (b_i'')^{(2)}((G_{19}), t) \rvert < (\hat{k}_{16})^{(2)} \lvert\lvert (G_{19}) - (G_{19})' \rvert\rvert e^{-(\hat{M}_{16})^{(2)} t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}', t)$ and $(a_i'')^{(2)}(T_{17}, t)$. (T_{17}', t) and (T_{17}, t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}} [(a_i)^{(2)} + (a_i')^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}} [(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty} (a_i'')^{(3)} (T_{21}, t) = (p_i)^{(3)}$	113

$\lim_{G\to\infty}(b_i^{''})^{(3)}(G_{23},t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(3)}(T_{21}^{'},t) - (a_i^{''})^{(3)}(T_{21},t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}^{'}\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i^{''})^{(3)}(G_{23}{}^{'},t) - (b_i^{''})^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}{}^{'}\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'},t)$ and$(a_i^{''})^{(3)}(T_{21},t)$. $(T_{21}^{'},t)$ And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$	118

$\lim_{G\to\infty}(b_i^{''})^{(4)}\left((G_{27}),t\right) = \ (r_i)^{(4)}$ **<u>Definition of</u>** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}\left((G_{27}),t\right)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and$(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
<u>Definition of</u> $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}, i = 24,25,26$, satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (a_i)^{(4)} + (a_i^{'})^{(4)} + \ (\hat{A}_{24})^{(4)} + \ (\hat{P}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)} + (b_i^{'})^{(4)} + \ (\hat{B}_{24})^{(4)} + \ (\hat{Q}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(5)},\ (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}\left((G_{31}),t\right) \leq \ (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	122

$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t)=\ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\rvert\le(\hat{k}_{28})^{(5)}\lvert T_{29}-T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}((G_{31}),t)\rvert<(\hat{k}_{28})^{(5)}\lvert\lvert(G_{31})-(G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
Definition of $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and\ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(p_i)^{(5)},\ (r_i)^{(5)},i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)}+(a_i')^{(5)}+\ (\hat{A}_{28})^{(5)}+\ (\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)}+(b_i')^{(5)}+\ (\hat{B}_{28})^{(5)}+\ (\hat{Q}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i')^{(6)},(a_i'')^{(6)},(b_i)^{(6)},(b_i')^{(6)},(b_i'')^{(6)}>0,\quad i,j=32,33,34$ The functions $(a_i'')^{(6)},(b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)},\ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t)\le(p_i)^{(6)}\le(\hat{A}_{32})^{(6)}$	127

$(b_i'')^{(6)}((G_{35}),t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2\to\infty}(a_i'')^{(6)}(T_{33},t) = (p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}((G_{35}),t) = (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\|(a_i'')^{(6)}(T_{33}',t) - (a_i'')^{(6)}(T_{33},t)\| \leq (\hat{k}_{32})^{(6)}\|T_{33} - T_{33}'\|e^{-(\hat{M}_{32})^{(6)}t}$ $\|(b_i'')^{(6)}((G_{35})',t) - (b_i'')^{(6)}((G_{35}),t)\| < (\hat{k}_{32})^{(6)}\|\|(G_{35}) - (G_{35})'\|\|e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}',t)$ and $(a_i'')^{(6)}(T_{33},t)$. (T_{33}',t) and (T_{33},t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}, \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
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Where we suppose	
(CCCCCC) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (DDDDDD) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$:	131

$(a_i'')^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39},t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	
(EEEEEE) $\lim_{T_2\to\infty} (a_i'')^{(7)}(T_{37},t) = (p_i)^{(7)}$ *(FFFFFF)* $\lim_{G\to\infty}(b_i'')^{(7)}((G_{39}),t) = (r_i)^{(7)}$ **<u>Definition of</u>** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}',t) - (a_i'')^{(7)}(T_{37},t)\rvert \leq (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})',t) - (b_i'')^{(7)}((G_{39}),t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}',t)$ and$(a_i'')^{(7)}(T_{37},t)$. (T_{37}',t) and (T_{37},t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i'')^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (GGGGGG) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
<u>Definition of</u> $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (HHHHHH) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	

$(a_i)^{(8)},(a_i^{'})^{(8)},(a_i^{''})^{(8)},(b_i)^{(8)},(b_i^{'})^{(8)},(b_i^{''})^{(8)}>0, \quad i,j=40,41,42$	136
The functions $(a_i^{''})^{(8)},(b_i^{''})^{(8)}$ are positive continuous increasing and bounded	
<u>**Definition of**</u> $(p_i)^{(8)},\ (r_i)^{(8)}$:	137
$(a_i^{''})^{(8)}(T_{41},t)\le(p_i)^{(8)}\le(\hat{A}_{40})^{(8)}$	138
$(b_i^{''})^{(8)}((G_{43}),t)\le\ (r_i)^{(8)}\le(b_i^{'})^{(8)}\le(\hat{B}_{40})^{(8)}$	139
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$\lim_{G\to\infty}(b_i^{''})^{(8)}\big((G_{43}),t\big)=\ (r_i)^{(8)}$	141
<u>**Definition of**</u> $(\hat{A}_{40})^{(8)},(\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)},(\hat{B}_{40})^{(8)},(p_i)^{(8)},\ (r_i)^{(8)}}$ are positive constants and $\boxed{i=40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'},t)-(a_i^{''})^{(8)}(T_{41},t)\rvert\le(\hat{k}_{40})^{(8)}\lvert T_{41}-T_{41}^{'}\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i^{''})^{(8)}((G_{43})',t)-(b_i^{''})^{(8)}\big((G_{43}),t\big)\rvert<(\hat{k}_{40})^{(8)}\lvert\lvert(G_{43})-(G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}^{'},t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. $(T_{41}^{'},t)$ and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)}=1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\ ,\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}<1$	144
<u>**Definition of**</u> $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i^{'})^{(8)},(b_i)^{(8)},(b_i^{'})^{(8)},(p_i)^{(8)},\ (r_i)^{(8)},i=40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[\,(a_i)^{(8)}+(a_i^{'})^{(8)}+\ (\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145

$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i^{'})^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i^{'})^{(9)},(a_i^{''})^{(9)},(b_i)^{(9)},(b_i^{'})^{(9)},(b_i^{''})^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i^{''})^{(9)},(b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)},\ (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t)\leq(p_i)^{(9)}\leq(\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t)\leq\ (r_i)^{(9)}\leq(b_i^{'})^{(9)}\leq(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i^{''})^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i^{''})^{(9)}(G_{47},t)=\ (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $\boxed{(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)}}$ are positive constants and $\boxed{i=44,45,46}$	
They satisfy Lipschitz condition: $\|(a_i^{''})^{(9)}(T_{45}^{'},t)-(a_i^{''})^{(9)}(T_{45},t)\|\leq(\hat{k}_{44})^{(9)}\|T_{45}-T_{45}^{'}\|e^{-(\hat{M}_{44})^{(9)}t}$ $\|(b_i^{''})^{(9)}((G_{47})^{'},t)-(b_i^{''})^{(9)}((G_{47}),t)\|<(\hat{k}_{44})^{(9)}\|\|(G_{47})-(G_{47})^{'}\|\|e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ ,\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)}and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i^{'})^{(9)},(b_i)^{(9)},(b_i^{'})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)},i=44,45,46,$ satisfy the inequalities	

$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	152

$G_i(t) \leq \left(\hat{P}_{32} \right)^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	

$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)}) \right) G_{16}(s_{(16)}) \right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)}) \right) G_{17}(s_{(16)}) \right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}(s_{(16)}), s_{(16)}) \right) G_{18}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19}(s_{(16)}), s_{(16)}) \right) T_{16}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19}(s_{(16)}), s_{(16)}) \right) T_{17}(s_{(16)}) \right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19}(s_{(16)}), s_{(16)}) \right) T_{18}(s_{(16)}) \right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{20}\left(s_{(20)}\right)\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}\left(s_{(20)}\right) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{21}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{22}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{20}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}\left(s_{(20)}\right) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{21}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{\mathrm{T}}_{22}(\mathrm{t}) = \mathrm{T}_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{22}\left(s_{(20)}\right)\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}\left(s_{(24)}\right) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{24}\left(s_{(24)}\right)\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}\left(s_{(24)}\right) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{25}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}\left(s_{(24)}\right) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{26}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}\left(s_{(24)}\right) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{24}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}\left(s_{(24)}\right) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{25}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{\mathrm{T}}_{26}(\mathrm{t}) = \mathrm{T}_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}\left(s_{(24)}\right) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{26}\left(s_{(24)}\right)\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{28}\,)^{(5)} \, , T_i^0 \leq (\, \hat{Q}_{28}\,)^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{28}\,)^{(5)} e^{(\, \hat{M}_{28}\,)^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{28}\,)^{(5)} e^{(\, \hat{M}_{28}\,)^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i \, , \, T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{32}\,)^{(6)} \, , T_i^0 \leq (\, \hat{Q}_{32}\,)^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{32}\,)^{(6)} e^{(\, \hat{M}_{32}\,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{32}\,)^{(6)} e^{(\, \hat{M}_{32}\,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	

$\overline{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{36})^{(7)}, T_i^0 \leq (\hat{Q}_{36})^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\overline{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \le (\hat{P}_{44})^{(9)}, T_i^0 \le (\hat{Q}_{44})^{(9)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	167

$G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0 \right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0} \right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}} \right) \right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1 \right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0 \right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0} \right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that	174

$(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0+\int_0^t\left[(a_{28})^{(5)}\left(G_{29}^0+(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\right)\right]\,ds_{(28)} =$ $\left(1+(a_{28})^{(5)}t\right)G_{29}^0+\frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t}-1\right)$	
From which it follows that $(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{P}_{28})^{(5)}+G_{29}^0\right)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)}+(\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0+\int_0^t\left[(a_{32})^{(6)}\left(G_{33}^0+(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}s_{(32)}}\right)\right]\,ds_{(32)} =$ $\left(1+(a_{32})^{(6)}t\right)G_{33}^0+\frac{(a_{32})^{(6)}(\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left(e^{(\hat{M}_{32})^{(6)}t}-1\right)$	176
From which it follows that $(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(w) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0+\int_0^t\left[(a_{36})^{(7)}\left(G_{37}^0+(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right]\,ds_{(36)} =$ $\left(1+(a_{36})^{(7)}t\right)G_{37}^0+\frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t}-1\right)$	178
From which it follows that $(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$	

(G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}} \right) \right] ds_{(40)} =$ $\left(1 + (a_{40})^{(8)} t\right) G_{41}^0 + \frac{(a_{40})^{(8)} (\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}} \left(e^{(\hat{M}_{40})^{(8)} t} - 1 \right)$	180
From which it follows that $(G_{40}(t) - G_{40}^0) e^{-(\hat{M}_{40})^{(8)} t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}} \left[((\hat{P}_{40})^{(8)} + G_{41}^0) e^{\left(-\frac{(\hat{P}_{40})^{(8)} + G_{41}^0}{G_{41}^0} \right)} + (\hat{P}_{40})^{(8)} \right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} \left(G_{45}^0 + (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} s_{(44)}} \right) \right] ds_{(44)} =$ $\left(1 + (a_{44})^{(9)} t\right) G_{45}^0 + \frac{(a_{44})^{(9)} (\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}} \left(e^{(\hat{M}_{44})^{(9)} t} - 1 \right)$	
From which it follows that $(G_{44}(t) - G_{44}^0) e^{-(\hat{M}_{44})^{(9)} t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}} \left[((\hat{P}_{44})^{(9)} + G_{45}^0) e^{\left(-\frac{(\hat{P}_{44})^{(9)} + G_{45}^0}{G_{45}^0} \right)} + (\hat{P}_{44})^{(9)} \right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for $G_{45}, G_{46}, T_{44}, T_{45}, T_{46}$	
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Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,t]$ From the hypotheses it follows	272
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condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ and $(\hat{Q}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on $(G_{43})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 37 There does not exist any t where $G_i(t) = 0$ and $T_i(t) = 0$ 275

it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)} - (a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ and $\left((\widehat{M}_{40})^{(8)}\right)_3$: 276

Remark 38: if G_{40} is bounded, the same property have also G_{41} and G_{42} . indeed if

$G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)}G_{41}$ and by integrating

$$G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}')^{(8)}$$

In the same way , one can obtain

$$G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}')^{(8)}$$

If G_{41} or G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.

Remark 39: If G_{40} is bounded, from below, the same property holds for G_{41} and G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below. 277

Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. 278

Definition of $(m)^{(8)}$ and ε_8 :

Indeed let t_8 be so that for $t > t_8$

$$(b_{41})^{(8)} - (b_i'')^{(8)}\left((G_{43})(t),t\right) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$$

Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to 279

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right)$, $t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\left((G_{43})(t), t(t), t\right) = (b_{42}')^{(8)}$

It is now sufficient to take $\frac{(a_i)^{(9)}}{(\mathcal{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\mathcal{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\mathcal{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\mathcal{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) = \sup_i\{\max_{t\in\mathbb{R}_+}|G_i^{(1)}(t) - G_i^{(2)}(t)|e^{-(\mathcal{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}|T_i^{(1)}(t) - T_i^{(2)}(t)|e^{-(\mathcal{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $(\widetilde{(G_{47})}, \widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}), (T_{47}))$
It results

$$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)}|G_{45}^{(1)} - G_{45}^{(2)}|e^{-(\mathcal{M}_{44})^{(9)}s_{(44)}}e^{(\mathcal{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} + \int_0^t\{(a_{44}')^{(9)}|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\mathcal{M}_{44})^{(9)}s_{(44)}}e^{-(\mathcal{M}_{44})^{(9)}s_{(44)}} + (a_{44}'')^{(9)}(T_{45}^{(1)}, s_{(44)})|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\mathcal{M}_{44})^{(9)}s_{(44)}}e^{(\mathcal{M}_{44})^{(9)}s_{(44)}} + G_{44}^{(2)}|(a_{44}'')^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a_{44}'')^{(9)}(T_{45}^{(2)}, s_{(44)})|\ e^{-(\mathcal{M}_{44})^{(9)}s_{(44)}}e^{(\mathcal{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}|e^{-(\mathcal{M}_{44})^{(9)}t} \leq \frac{1}{(\mathcal{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_{+}$. If instead of proving the existence of the solution on $\mathbb{R}_{+}$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 42: There does not exist any t where $G_i\,(t) = 0\ and\ T_i\,(t) = 0$ From 99 to 44 it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)}t)} > 0$ for $t > 0$	
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Remark 44: If G_{44} *is* bounded, from below, the same property holds for $G_{45}\ and\ G_{46}$. The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.	
Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}\,(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	

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Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a'_{13})^{(1)} + (a'_{14})^{(1)} - (a''_{13})^{(1)}(T_{14}, t) + (a''_{14})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G, t) - (b''_{14})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
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Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
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$\Big(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\Big[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\Big] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq$ $\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\big[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\big] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\Big)$	286
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$\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	
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Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
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Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}\left((G_{23}), t\right) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
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and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ ,\boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a'_{22})^{(3)})}[e^{(S_1)^{(3)}t} - e^{-(a'_{22})^{(3)}t}] + G_{22}^0 e^{-(a'_{22})^{(3)}t}\right)$	324
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$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
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Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
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and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\left((G_{31}), t\right) - (b_{29}'')^{(5)}\left((G_{31}), t\right) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0, (\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0, (u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,	340

and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},\ \textbf{\textit{if}}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \textbf{\textit{if}}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \textbf{\textit{if}}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \textbf{\textit{if}}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ (a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b'_{30})^{(5)}t}\right] + T_{30}^0 e^{-(b'_{30})^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a'_{28})^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b'_{28})^{(5)}$ $(R_2)^{(5)} = (b'_{30})^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \le -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \le -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \le -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \le -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)}, , (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \; \boldsymbol{if} \; (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \; (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \; \boldsymbol{if} \; (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if} \; (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \; (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \le G_{32}(t) \le G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)}G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)}T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)}T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
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Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the	362

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2+(\sigma_2)^{(7)}\nu^{(7)}-(a_{36})^{(7)}=0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2+(\tau_2)^{(7)}u^{(7)}-(b_{36})^{(7)}=0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)}=(\nu_0)^{(7)}, (m_1)^{(7)}=(\nu_1)^{(7)}, \textit{ if } (\nu_0)^{(7)}<(\nu_1)^{(7)}$ $(m_2)^{(7)}=(\nu_1)^{(7)}, (m_1)^{(7)}=(\bar{\nu}_1)^{(7)}, \textit{ if } (\nu_1)^{(7)}<(\nu_0)^{(7)}<(\bar{\nu}_1)^{(7)}$, and $(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}$ $(m_2)^{(7)}=(\nu_1)^{(7)}, (m_1)^{(7)}=(\nu_0)^{(7)}, \textit{ if } (\bar{\nu}_1)^{(7)}<(\nu_0)^{(7)}$	
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$\left(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t}-e^{-(S_2)^{(7)}t}\right]+G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t}-e^{-(a_{38}')^{(7)}t}\right]+G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
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$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
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$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	
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$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, $\boldsymbol{if}$ $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}$ $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}$ $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
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$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$$

$$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \le -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \le -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \le -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \le -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if}\ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if}\ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if}\ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if}\ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if}\ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$
are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14}, t) \right) - (a_{14}'')^{(1)}(T_{14}, t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} \right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} \right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)}+(C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}}{1+(C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)}+(\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

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$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$$

<u>Definition of</u> $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

<u>Definition of</u> $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

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If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
Proof : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **Definition of** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	405
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If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right) - (a_{33}'')^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$

If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$$

If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)},\quad\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)},\quad\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \le \frac{d\nu^{(7)}}{dt} \le -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \ge \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \le \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \le \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \le \nu^{(7)}(t) \le$$

$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420
Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$	421

From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	424

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

Proof : From 99,20,44,22,23,44 we obtain 424 A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \le \frac{d\nu^{(9)}}{dt} \le -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \ge \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \le \nu^{(9)}(t) \le (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \le \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \le \nu^{(9)}(t) \le (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \le \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \le \nu^{(9)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \le (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$ if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

$with$ $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system

Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations 426

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$ 427

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$ 428

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$, 429

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem :** If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

$with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\,]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (w) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) + (a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)} G_{14}}{[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)} G_{14}}{[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	
$G_{16} = \frac{(a_{16})^{(2)} G_{17}}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)} G_{17}}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^{*})]}$	499
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*})=0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*})=0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right] + (b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*})=0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right] + (b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{25} such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{29} such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{33} such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{37} such that $\varphi(G_{39}{}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^{*} given by $\varphi((G_{31})^{*}) = 0$, T_{29}^{*} given by $f(T_{29}^{*}) = 0$ and

$$G_{28}^{*} = \frac{(a_{28})^{(5)} G_{29}^{*}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]} \quad , \quad G_{30}^{*} = \frac{(a_{30})^{(5)} G_{29}^{*}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$$

$$T_{28}^{*} = \frac{(b_{28})^{(5)} T_{29}^{*}}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^{*})]} \quad , \quad T_{30}^{*} = \frac{(b_{30})^{(5)} T_{29}^{*}}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^{*})]}$$ 519

Obviously, these values represent an equilibrium solution of global equations

Finally we obtain the unique solution 520

G_{33}^{*} given by $\varphi((G_{35})^{*}) = 0$, T_{33}^{*} given by $f(T_{33}^{*}) = 0$ and

$$G_{32}^{*} = \frac{(a_{32})^{(6)} G_{33}^{*}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]} \quad , \quad G_{34}^{*} = \frac{(a_{34})^{(6)} G_{33}^{*}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$$

$$T_{32}^{*} = \frac{(b_{32})^{(6)} T_{33}^{*}}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^{*})]} \quad , \quad T_{34}^{*} = \frac{(b_{34})^{(6)} T_{33}^{*}}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^{*})]}$$ 521

Obviously, these values represent an equilibrium solution of global equations

Finally we obtain the unique solution 522

G_{37}^{*} given by $\varphi((G_{39})^{*}) = 0$, T_{37}^{*} given by $f(T_{37}^{*}) = 0$ and

$$G_{36}^{*} = \frac{(a_{36})^{(7)} G_{37}^{*}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]} \quad , \quad G_{38}^{*} = \frac{(a_{38})^{(7)} G_{37}^{*}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$$

$$T_{36}^{*} = \frac{(b_{36})^{(7)} T_{37}^{*}}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^{*})]} \quad , \quad T_{38}^{*} = \frac{(b_{38})^{(7)} T_{37}^{*}}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^{*})]}$$

Finally we obtain the unique solution 523

G_{41}^{*} given by $\varphi((G_{43})^{*}) = 0$, T_{41}^{*} given by $f(T_{41}^{*}) = 0$ and

$$G_{40}^{*} = \frac{(a_{40})^{(8)} G_{41}^{*}}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^{*})]} \quad , \quad G_{42}^{*} = \frac{(a_{42})^{(8)} G_{41}^{*}}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^{*})]}$$

$$T_{40}^{*} = \frac{(b_{40})^{(8)} T_{41}^{*}}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^{*})]} \quad , \quad T_{42}^{*} = \frac{(b_{42})^{(8)} T_{41}^{*}}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^{*})]}$$

Finally we obtain the unique solution of 89 to 99 523 A

G_{45}^{*} given by $\varphi((G_{47})^{*}) = 0$, T_{45}^{*} given by $f(T_{45}^{*}) = 0$ and

$$G_{44}^{*} = \frac{(a_{44})^{(9)} G_{45}^{*}}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^{*})]} \quad , \quad G_{46}^{*} = \frac{(a_{46})^{(9)} G_{45}^{*}}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^{*})]}$$

$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$

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Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof:_Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)} \ , \ \frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$$

Then taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$$ 525

$$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$$ 526

$$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$$ 527

$$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$$ 528

$$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$$ 529

$$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$$ 530

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Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$ 532

$$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \ , \ \frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$$ 533

taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$$ 534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*}) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	547
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i'')^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left(\,(G_{39})^{**}\,\right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^{*}\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^{*}\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^{*}\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^{*}\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^{*}) = (q_{41})^{(8)} \;,\; \frac{\partial (b_i^{''})^{(8)}}{\partial G_j}\left((G_{43})^{*}\right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^{*}\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^{*}\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}} (T_{45}^*) = (q_{45})^{(9)} \ , \ \frac{\partial (b_i'')^{(9)}}{\partial G_j} ((G_{47})^*) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)} G_{44}^* \mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)} G_{45}^* \mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)} G_{46}^* \mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)} T_{44}^* \mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)} T_{45}^* \mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)} T_{46}^* \mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)} G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right) s_{(14),(14)} T_{14}^* + (b_{14})^{(1)} s_{(13),(14)} T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}')^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)} G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)} G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right) s_{(14),(13)} T_{14}^* + (b_{14})^{(1)} s_{(13),(13)} T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)(q_{15})^{(1)} G_{15}$ $+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right) \left((a_{15})^{(1)}(q_{14})^{(1)} G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)} G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right) s_{(14),(15)} T_{14}^* + (b_{14})^{(1)} s_{(13),(15)} T_{13}^*\right)\} = 0$ +	

$$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$$

$$+\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$$

+

$((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(((\lambda)^{(4)})^{2}+((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^{2}+((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)})(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^{2}+((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)})(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)})s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(((\lambda)^{(5)})^{2}+((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^{2}+((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)})(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^{2}+((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)})(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)})s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$ +	

$$\left((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}')^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}')^{(7)}+(b_{37}')^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$((\lambda)^{(8)} + (b'_{42})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a'_{42})^{(8)} + (p_{42})^{(8)})$

$\left[\left(((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(q_{40})^{(8)}G^*_{40}\right)\right]$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T^*_{41} + (b_{41})^{(8)}s_{(40),(41)}T^*_{41}\right)$

$+\left(((\lambda)^{(8)} + (a'_{41})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G^*_{40} + (a_{40})^{(8)}(q_{41})^{(8)}G^*_{41}\right)$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T^*_{41} + (b_{41})^{(8)}s_{(40),(40)}T^*_{40}\right)$

$\left(((\lambda)^{(8)})^2 + ((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})(\lambda)^{(8)}\right)$

$\left(((\lambda)^{(8)})^2 + ((b'_{40})^{(8)} + (b'_{41})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)})(\lambda)^{(8)}\right)$

$+\left(((\lambda)^{(8)})^2 + ((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G^*_{41} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G^*_{40}\right)$

$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T^*_{41} + (b_{41})^{(8)}s_{(40),(42)}T^*_{40}\right)\} = 0$

$+$

$((\lambda)^{(9)} + (b'_{46})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a'_{46})^{(9)} + (p_{46})^{(9)})$

$\left[\left(((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(q_{44})^{(9)}G^*_{44}\right)\right]$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T^*_{45} + (b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$

$+\left(((\lambda)^{(9)} + (a'_{45})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G^*_{44} + (a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T^*_{45} + (b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$

$\left(((\lambda)^{(9)})^2 + ((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})(\lambda)^{(9)}\right)$

$\left(((\lambda)^{(9)})^2 + ((b'_{44})^{(9)} + (b'_{45})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)})(\lambda)^{(9)}\right)$

$+\left(((\lambda)^{(9)})^2 + ((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$

$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T^*_{45} + (b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\} = 0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION TWENTY FOUR

Cosmic Strings

INTRODUCTION—VARIABLES USED

Renormalized scalar propagator around a dispiration V. A. De Lorenci and E. S. Moreira Jr. Phys. Rev. D 67, 124002 – Published 2 June 2003

(1) Such a new effect resembles that where an induced vacuum current arises around (e&eb) a needle solenoid carrying (e&eb) a magnetic flux (the Aharonov-Bohm effect), and may have (e) physical consequences.
(2) Connections with a closely related background, namely the spacetime of (e) a spinning cosmic string, are briefly addressed. Received 23 January 2003 DOI: http://dx.doi.org/10.1103/PhysRevD.67.124002

Cosmic strings M B Hindmarsh and T W B Kibble Reports on Progress in Physics, Volume 58, and Number 5

(1) The topic of cosmic strings provides a bridge between the physics of the very small and (e&eb) the very large.
(2) They are predicted by some unified theories of particle interactions. If they exist, they may help to (eb) explain some of the largest-scale structures seen in the Universe today.
(3) They are 'topological defects' that may have been formed at (eb) phase transitions in the very early history of the Universe, analogous to (e&eb) those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals.
(4) In this review, authors describe what they are, why they have been hypothesized and what their cosmological implications would be. The relevant background from the standard models of particle physics and cosmology is described in section 1. In section 2, we review the idea of symmetry breaking (e) in field theories, and show how the defects formed is constrained by (e&eb) the topology of the manifold of (e) degenerate vacuum states.
(5) They also discuss the different types of cosmic strings that can appear in (eb) different field theories. Section 3 is devoted to the dynamics of cosmic strings, and section 4 to their interaction with other fields. The formation and evolution of cosmic strings in the early Universe is the subject of section 5, while section 6 deals with their observational implications. Finally, the present status of the theory is reviewed in section 7.

A Model for Lightcone Fluctuations due to Stress Tensor Fluctuations C.H.G. Bessa, V.A. De Lorenci, L.H. Ford, C.C.H. Ribeiro **(6)** Authors study a model for quantum lightcone fluctuations in which vacuum fluctuations of the electric field and of the squared electric field in a nonlinear dielectric material produce variations in the flight times of probe pulses. When this material has a non-zero third order polarizability, the flight time variations arise from squared electric field fluctuations, and are analogous to effects expected when the stress tensor of a quantized field drives passive spacetime geometry fluctuations. We also discuss the dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines a sampling function for averaging the squared electric field along the path of the pulse. This allows us to estimate the probability of especially large fluctuations, which is a measure of the probability distribution for quantum stress tensor fluctuations. Subjects: General Relativity and Quantum Cosmology (gr-qc); High Energy Physics - Theory (hep-th); Quantum Physics (quant-ph) Cite as: arXiv:1602.03857 [gr-qc] (or arXiv:1602.03857v1 [gr-qc] for this version)	
NOTATION	
Module One In particular it is shown that the dispiration polarizes the vacuum giving rise to an energy momentum tensor which, as seen from (e) a local inertial frame, presents (eb) nonvanishing off-diagonal components	
G_{13} : Category one of local inertial frame, presents (eb) nonvanishing off-diagonal components G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of dispiration polarizes the vacuum giving rise to an energy momentum tensor which, as seen from T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two In particular it is shown that the dispiration polarizes the vacuum giving rise to an energy momentum tensor which, as seen from a local inertial frame, presents (eb) nonvanishing off-diagonal components	
G_{16} : Category one of **dispiration polarizes the vacuum giving rise to an energy momentum tensor which, as seen from a local inertial frame;** nonvanishing off-diagonal components G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of nonvanishing off-diagonal components; **dispiration polarizes the vacuum giving rise to an energy momentum tensor which, as seen from a local inertial frame** T_{17} : Category two of SAS T_{18} : Category three of SAS	

Module three Such a new effect resembles that where an induced vacuum current arises around (e&eb) a needle solenoid carrying (e&eb) a magnetic flux (the Aharonov-Bohm effect), and may have (e) physical consequences	
G_{20} : Category one of **new effect resembles that where an induced vacuum current;** needle solenoid carrying (e&eb) a magnetic flux (the Aharonov-Bohm effect), and may have (e) physical consequences G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of needle solenoid carrying (e&eb) a magnetic flux (the Aharonov-Bohm effect), and may have (e) physical consequences **;new effect resembles that where an induced vacuum current** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Such a new effect resembles that where an induced vacuum current arises around a needle solenoid carrying (e&eb) a magnetic flux (the Aharonov-Bohm effect), and may have (e) physical consequences	
G_{24} : Category one of **new effect resembles that where an induced vacuum current arises around a needle solenoid;** magnetic flux (the Aharonov-Bohm effect), and may have (e) physical consequences G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of magnetic flux (the Aharonov-Bohm effect), and may have (e) physical consequences; **new effect resembles that where an induced vacuum current arises around a needle solenoid** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five In particular it is shown that the dispiration polarizes the vacuum giving rise to an energy momentum tensor which, as seen from a local inertial frame, presents nonvanishing off-diagonal components Connections with a closely related background, namely the spacetime of a spinning cosmic string, are briefly addressed . Received 23 January 2003 DOI: http://dx.doi.org/10.1103/PhysRevD.67.124002	
G_{28} : Category one of **dispiration polarizes the vacuum giving rise to an energy momentum tensor which, as seen from a local inertial frame, presents nonvanishing off-diagonal components;** the spacetime of a spinning cosmic string G_{29} : Category two of SAS	

G_{30} : Category three of SAS	
T_{28} : Category one of the spacetime of a spinning cosmic string **;dispiration polarizes the vacuum giving rise to an energy momentum tensor which, as seen from a local inertial frame, presents nonvanishing off-diagonal components** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six The topic of cosmic strings provides a bridge between the physics of the very small and (e&eb) the very large	
G_{32} : Category one of **physics of the very small;** physics of the very large G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of physics of the very large **; physics of the very small** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven They are predicted by some unified theories of particle interactions. If cosmic strings exist, they may help to (eb) explain some of the largest-scale structures seen in the Universe today	
G_{36} : Category one of cosmic strings G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of explanation of some of the largest-scale structures seen in the Universe today T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight They are 'topological defects' that may have been formed at (eb) phase transitions in the very early history of the Universe, analogous to (e&eb) those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals	

G_{40} : Category one of **'topological defects' ;** phase transitions in the very early history of the Universe, analogous to (e&eb) those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of phase transitions in the very early history of the Universe, analogous to (e&eb) those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals; **'topological defects'** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine They are 'topological defects' that may have been formed at phase transitions in the very early history of the Universe, analogous to (e&eb) those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals	
G_{44} : Category one of **'topological defects' that may have been formed at phase transitions in the very early history of the Universe;** those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals; **'topological defects' that may have been formed at phase transitions in the very early history of the Universe,** T_{45} : Category two of SAS T_{46} : Category three of SAS	

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients	

$(a_{13}')^{(1)}, (a_{14}')^{(1)}, (a_{15}')^{(1)}, (b_{13}')^{(1)}, (b_{14}')^{(1)}, (b_{15}')^{(1)}, (a_{16}')^{(2)}, (a_{17}')^{(2)}, (a_{18}')^{(2)}, (b_{16}')^{(2)}, (b_{17}')^{(2)}, (b_{18}')^{(2)}$ $, (a_{20}')^{(3)}, (a_{21}')^{(3)}, (a_{22}')^{(3)}, (b_{20}')^{(3)}, (b_{21}')^{(3)}, (b_{22}')^{(3)}$ $(a_{24}')^{(4)}, (a_{25}')^{(4)}, (a_{26}')^{(4)}, (b_{24}')^{(4)}, (b_{25}')^{(4)}, (b_{26}')^{(4)}, (b_{28}')^{(5)}, (b_{29}')^{(5)}, (b_{30}')^{(5)} (a_{28}')^{(5)}, (a_{29}')^{(5)}, (a_{30}')^{(5)}$, $(a_{32}')^{(6)}, (a_{33}')^{(6)}, (a_{34}')^{(6)}, (b_{32}')^{(6)}, (b_{33}')^{(6)}, (b_{34}')^{(6)}$ $(a_{36}')^{(7)}, (a_{37}')^{(7)}, (a_{38}')^{(7)}, (b_{36}')^{(7)}, (b_{37}')^{(7)}, (b_{38}')^{(7)}$, $(a_{40}')^{(8)}, (a_{41}')^{(8)}, (a_{42}')^{(8)}, (b_{40}')^{(8)}, (b_{41}')^{(8)}, (b_{42}')^{(8)}$, $(a_{44}')^{(9)}, (a_{45}')^{(9)}, (a_{46}')^{(9)}, (b_{44}')^{(9)}, (b_{45}')^{(9)}, (b_{46}')^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G, t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b_{14}')^{(1)} - (b_{14}'')^{(1)}(G, t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G, t) \right] T_{15}$	6
$+(a_{13}'')^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b_{13}'')^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}, t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17}, t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}, t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19}), t) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b_{17}')^{(2)} - (b_{17}'')^{(2)}((G_{19}), t) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19}), t) \right] T_{18}$	12
$+(a_{16}'')^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b_{16}'')^{(2)}((G_{19}), t) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}, t) \right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21}, t) \right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}, t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23}, t) \right] T_{21}$	17

$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}'')^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}'')^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}')^{(4)} - (b_{26}'')^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}'')^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}')^{(5)} - (b_{28}'')^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}')^{(5)} - (b_{29}'')^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}')^{(5)} - (b_{30}'')^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}'')^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}'')^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}')^{(6)} - (b_{32}'')^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}')^{(6)} - (b_{33}'')^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}')^{(6)} - (b_{34}'')^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}'')^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	

$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37}, t) \right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37}, t) \right] G_{37}$	38
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}, t) \right] G_{38}$	39
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\left((G_{39}), t\right) \right] T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\left((G_{39}), t\right) \right] T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\left((G_{39}), t\right) \right] T_{38}$	42
$+(a''_{36})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41}, t) \right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}, t) \right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}), t\right) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}), t\right) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}), t\right) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	

$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}), t\right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}), t\right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}), t\right) \right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}), t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14}, t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{40})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14}, t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{41})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14}, t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{42})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{15}$	57

Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13} \quad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14} \quad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15} \quad 60$$

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{37})^{(7,7,)}(G_{39},t)$, $-(b''_{36})^{(7,7,)}(G_{39},t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8)}(G_{43},t)$ $-(b''_{41})^{(8,8)}(G_{43},t)$ $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	63
Where $+(a''_{16})^{(2)}(T_{17},t)$, $+(a''_{17})^{(2)}(T_{17},t)$, $+(a''_{18})^{(2)}(T_{17},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,)}(T_{14},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3 $+(a''_{44})^{(9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9)}(T_{45},t)$ are ninth augmentation coefficient for category 1, 2 and 3	

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16} \quad 64$$

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17} \quad 65$$

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18} \quad 66$$

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{20} \quad 67$$

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21} \quad 68$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[\begin{matrix} (a_{22}')^{(3)} \boxed{+(a_{22}'')^{(3)}(T_{21},t)} \boxed{+(a_{18}'')^{(2,2,2)}(T_{17},t)} \boxed{+(a_{15}'')^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22} \quad 69$$

$\boxed{+(a_{20}'')^{(3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}'')^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{36}'')^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{40}'')^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{44}'')^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[\begin{matrix} (b_{20}')^{(3)} \boxed{-(b_{20}'')^{(3)}(G_{23},t)} \boxed{-(b_{16}'')^{(2,2,2)}(G_{19},t)} \boxed{-(b_{13}'')^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[\begin{matrix} (b_{21}')^{(3)} \boxed{-(b_{21}'')^{(3)}(G_{23},t)} \boxed{-(b_{17}'')^{(2,2,2)}(G_{19},t)} \boxed{-(b_{14}'')^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[\begin{matrix} (b_{22}')^{(3)} \boxed{-(b_{22}'')^{(3)}(G_{23},t)} \boxed{-(b_{18}'')^{(2,2,2)}(G_{19},t)} \boxed{-(b_{15}'')^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{22} \quad 72$$

$\boxed{-(b_{20}'')^{(3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{16}'')^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{13}'')^{(1,1,1,)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3*

$-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3*

$-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3*

$-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$ $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3

$-(b''_{46})^{(9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t) + (a''_{28})^{(5,5,)}(T_{29},t) + (a''_{32})^{(6,6,)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1)}(T_{14},t) + (a''_{16})^{(2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{36})^{(7,7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8,8)}(T_{41},t) + (a''_{44})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25},t) + (a''_{29})^{(5,5,)}(T_{29},t) + (a''_{33})^{(6,6)}(T_{33},t) \\ +(a''_{14})^{(1,1,1,1)}(T_{14},t) + (a''_{17})^{(2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{37})^{(7,7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25},t) + (a''_{30})^{(5,5,)}(T_{29},t) + (a''_{34})^{(6,6,)}(T_{33},t) \\ +(a''_{15})^{(1,1,1,1)}(T_{14},t) + (a''_{18})^{(2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3)}(T_{21},t) \\ +(a''_{38})^{(7,7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9,9)}(T_{45},t) \end{bmatrix} G_{26} \quad 75$$

$(a''_{24})^{(4)}(T_{25},t)$, $(a''_{25})^{(4)}(T_{25},t)$, $(a''_{26})^{(4)}(T_{25},t)$ *are first augmentation coefficients category* 1, 2 3

$+(a''_{28})^{(5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3

$+(a''_{32})^{(6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3

$+(a''_{13})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1)}(T_{14},t)$
are fourth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{16})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2)}(T_{17},t)$
are fifth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{20})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3)}(T_{21},t)$
are sixth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$
are seventh augmentation coefficients for category 1, 2 *and* 3

$+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)$
are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3	
$$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\begin{bmatrix}(b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{24}$$	76
$$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\begin{bmatrix}(b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{25}$$	77
$$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\begin{bmatrix}(b'_{26})^{(4)}\boxed{-(b''_{26})^{(4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{26}$$	78
$Where$ $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ $are\ first\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ $are\ second\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ $are\ third\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ $are\ fourth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ $are\ fifth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ $are\ sixth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ $are\ seventh\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ $are\ eighth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\begin{bmatrix}(a'_{28})^{(5)}\boxed{+(a''_{28})^{(5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{28}$$	79
$$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\begin{bmatrix}(a'_{29})^{(5)}\boxed{+(a''_{29})^{(5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{29}$$	80

$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3	

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[\begin{matrix}(a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{32}$$	85
$$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\left[\begin{matrix}(a'_{33})^{(6)}\boxed{+(a''_{33})^{(6)}(T_{33},t)}\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{33}$$	86
$$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\left[\begin{matrix}(a'_{34})^{(6)}\boxed{+(a''_{34})^{(6)}(T_{33},t)}\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{34}$$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$	

Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34} \quad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 91$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14} \quad 92$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \quad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \quad 94$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	*95*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$(b_{42})^{(8)}T_{41} - \left[\begin{array}{l} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{array}{l} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{array}\right] G_{13}$	96
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{array}{l} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{array}\right] G_{14}$	

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b'_i)^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2 \to \infty} (a''_i)^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b''_i)^{(1)} (G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\lvert(a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)}$, $(r_i)^{(1)}, i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i')^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i')^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0, \quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq \left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}\left((G_{19}),t\right)= (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i=16,17,18$	106
They satisfy Lipschitz condition:	

$\lvert(a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)}+(a_i')^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i')^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)},\ (\mathrm{r}_i)^{(3)}$: $(a_i'')^{(3)}(T_{21},t)\leq(p_i)^{(3)}\leq(\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t)\leq\ (r_i)^{(3)}\leq(b_i')^{(3)}\leq(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}\,(T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}\,(G_{23},t)=\ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}$ are positive constants and $i=20,21,22$	113

They satisfy Lipschitz condition: $\lvert(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21}-T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i'')^{(3)}(G_{23}',t)-(b_i'')^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23}-G_{23}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and $(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}$, $\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}}<1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)},\ (r_i)^{(3)},i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[\,(a_i)^{(3)}+(a_i')^{(3)}+\ (\hat{A}_{20})^{(3)}+\ (\hat{P}_{20})^{(3)}\,(\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[\ (b_i)^{(3)}+(b_i')^{(3)}+\ (\hat{B}_{20})^{(3)}+\ (\hat{Q}_{20})^{(3)}\ (\hat{k}_{20})^{(3)}]<1$	116
Where we suppose	
$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)}>0,\quad i,j=24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t)\leq(p_i)^{(4)}\leq(\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}\big((G_{27}),t\big)\leq\ (r_i)^{(4)}\leq(b_i')^{(4)}\leq(\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}\big((G_{27}),t\big)=\ (r_i)^{(4)}$ **<u>Definition of</u>** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i=24,25,26}$	118
They satisfy Lipschitz condition:	119

$\lvert(a_i'')^{(4)}(T_{25}',t)-(a_i'')^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i'')^{(4)}((G_{27})',t)-(b_i'')^{(4)}\big((G_{27}),t\big)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and$(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $\big[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}\big]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
<u>**Definition of**</u> $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)}and\,(\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(p_i)^{(4)},\ (r_i)^{(4)},i=24{,}25{,}26$, satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\,(a_i)^{(4)}+(a_i')^{(4)}+\ (\hat{A}_{24})^{(4)}+\ (\hat{P}_{24})^{(4)}\,(\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)}+(b_i')^{(4)}+\ (\hat{B}_{24})^{(4)}+\ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i')^{(5)},(a_i'')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(b_i'')^{(5)}>0,\quad i,j=28{,}29{,}30$ The functions $(a_i'')^{(5)},(b_i'')^{(5)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(5)},\ (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t)\leq(p_i)^{(5)}\leq(\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}\big((G_{31}),t\big)\leq\ (r_i)^{(5)}\leq(b_i')^{(5)}\leq(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i'')^{(5)}\,(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}\,(G_{31},t)=\ (r_i)^{(5)}$ <u>**Definition of**</u> $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}}$ are positive constants and $\boxed{i=28{,}29{,}30}$	123

They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(5)}(T_{29}^{'},t)-(a_i^{''})^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29}-T_{29}^{'}\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert (b_i^{''})^{(5)}((G_{31})^{'},t)-(b_i^{''})^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert (G_{31})-(G_{31})^{'}\lvert\lvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and$(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
Definition of $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and\ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i^{'})^{(5)},(b_i)^{(5)},(b_i^{'})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)},i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)}+(a_i^{'})^{(5)}+\ (\hat{A}_{28})^{(5)}+\ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)}+(b_i^{'})^{(5)}+\ (\hat{B}_{28})^{(5)}+\ (\hat{Q}_{28})^{(5)}\ \ (\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i^{'})^{(6)},(a_i^{''})^{(6)},(b_i)^{(6)},(b_i^{'})^{(6)},(b_i^{''})^{(6)}>0,\quad i,j=32,33,34$ The functions $(a_i^{''})^{(6)},(b_i^{''})^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)},\ (r_i)^{(6)}$: $(a_i^{''})^{(6)}(T_{33},t)\leq(p_i)^{(6)}\leq(\hat{A}_{32})^{(6)}$ $(b_i^{''})^{(6)}((G_{35}),t)\leq\ (r_i)^{(6)}\leq(b_i^{'})^{(6)}\leq(\hat{B}_{32})^{(6)}$	127
$lim_{T_2\to\infty}(a_i^{''})^{(6)}(T_{33},t)=(p_i)^{(6)}$ $\lim_{G\to\infty}(b_i^{''})^{(6)}\left((G_{35}),t\right)=\ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$:	128

Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}',t) - (a_i'')^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)}\lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i'')^{(6)}((G_{35})',t) - (b_i'')^{(6)}\big((G_{35}),t\big)\rvert < (\hat{k}_{32})^{(6)}\lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}',t)$ and $(a_i'')^{(6)}(T_{33},t)$. (T_{33}',t) and (T_{33},t) are points belonging to the interval $\big[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\big]$. It is to be noted that $(a_i'')^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>**Definition of**</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and\ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i')^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)}\ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i')^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)}\ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(IIIIII) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (JJJJJJ) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39},t) \leq \ (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(KKKKKK) $\lim_{T_2\to\infty} (a_i'')^{(7)}(T_{37},t) = (p_i)^{(7)}$ *(LLLLLL)* $\lim_{G\to\infty}(b_i'')^{(7)}\big((G_{39}),t\big) = \ (r_i)^{(7)}$	132

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$	
They satisfy Lipschitz condition: $\|(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\| \leq (\hat{k}_{36})^{(7)}\|T_{37} - T_{37}'\|e^{-(\hat{M}_{36})^{(7)}t}$ $\|(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\| < (\hat{k}_{36})^{(7)}\|\|(G_{39}) - (G_{39})'\|\|e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (MMMMMM) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (NNNNNN) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)}$ *and* $(\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i, j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138

$(b_i'')^{(8)}((G_{43}),t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
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$\lim_{G\to\infty}(b_i'')^{(8)}\left((G_{43}),t\right) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t) - (a_i'')^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}\left((G_{43}),t\right)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
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$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i')^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)},\ (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$	
$\lim_{T_2\to\infty} (a_i^{''})^{(9)}(T_{45},t) = (p_i)^{(9)}$ $\lim_{G\to\infty} (b_i^{''})^{(9)}(G_{47},t) = (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$: Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)},\ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t)\rvert \leq (\hat{k}_{44})^{(9)}\lvert T_{45} - T_{45}^{'}\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}((G_{47}),t)\rvert < (\hat{k}_{44})^{(9)}\lvert\lvert(G_{47}) - (G_{47})^{'}\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $\left[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\right]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)},\ (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities $\frac{1}{(\hat{M}_{44})^{(9)}}[\ (a_i)^{(9)} + (a_i^{'})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}] < 1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)} + (b_i^{'})^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}] < 1$	

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13}\right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$:	153

$G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{16})^{(2)} , T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{20})^{(3)} , T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a'_{20})^{(3)} + a''_{20})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{22}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{20}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}\left(s_{(20)}\right) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{21}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{22}\left(s_{(20)}\right)\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}\left(s_{(24)}\right) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{24}\left(s_{(24)}\right)\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}\left(s_{(24)}\right) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{25}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}\left(s_{(24)}\right) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{26}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}\left(s_{(24)}\right) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{24}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}\left(s_{(24)}\right) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{25}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}\left(s_{(24)}\right) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{26}\left(s_{(24)}\right)\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{32})^{(6)}$, $T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a'_{32})^{(6)} + a''_{32})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \ , \ T_i(0) = T_i^0 \ , \ G_i^0 \le (\ \hat{P}_{36}\ )^{(7)} \ , T_i^0 \le (\ \hat{Q}_{36}\ )^{(7)},$	
$0 \le G_i(t) - G_i^0 \le (\ \hat{P}_{36}\ )^{(7)} e^{(\ \hat{M}_{36}\ )^{(7)} t}$	
$0 \le T_i(t) - T_i^0 \le (\ \hat{Q}_{36}\ )^{(7)} e^{(\ \hat{M}_{36}\ )^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}')^{(7)} + a_{36}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}')^{(7)} - (b_{36}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}')^{(7)} - (b_{37}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{\mathrm{T}}_{38}(\mathrm{t}) = \mathrm{T}_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}')^{(7)} - (b_{38}'')^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \ , \ T_i(0) = T_i^0 \ , \ G_i^0 \le (\ \hat{P}_{40}\ )^{(8)} \ , T_i^0 \le (\ \hat{Q}_{40}\ )^{(8)},$	
$0 \le G_i(t) - G_i^0 \le (\ \hat{P}_{40}\ )^{(8)} e^{(\ \hat{M}_{40}\ )^{(8)} t}$	
$0 \le T_i(t) - T_i^0 \le (\ \hat{Q}_{40}\ )^{(8)} e^{(\ \hat{M}_{40}\ )^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}')^{(8)} + a_{40}'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}')^{(8)} + (a_{41}'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}\left(s_{(40)}\right) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{42}\left(s_{(40)}\right)\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}\left(s_{(40)}\right) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{40}\left(s_{(40)}\right)\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}\left(s_{(40)}\right) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{41}\left(s_{(40)}\right)\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}\left(s_{(40)}\right) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{42}\left(s_{(40)}\right)\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}\left(s_{(44)}\right) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{44}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}\left(s_{(44)}\right) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{45}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}\left(s_{(44)}\right) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{46}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}\left(s_{(44)}\right) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{44}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}\left(s_{(44)}\right) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{45}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}\left(s_{(44)}\right) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{46}\left(s_{(44)}\right)\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that	168

$(G_{13}(t)-G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[((\hat{P}_{13})^{(1)}+G_{14}^0)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)}+(\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0+\int_0^t\left[(a_{16})^{(2)}\left(G_{17}^0+(\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right]ds_{(16)}=$ $\left(1+(a_{16})^{(2)}t\right)G_{17}^0+\frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t}-1\right)$	169
From which it follows that $(G_{16}(t)-G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[((\hat{P}_{16})^{(2)}+G_{17}^0)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)}+(\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0+\int_0^t\left[(a_{20})^{(3)}\left(G_{21}^0+(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right]ds_{(20)}=$ $\left(1+(a_{20})^{(3)}t\right)G_{21}^0+\frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t}-1\right)$	171
From which it follows that $(G_{20}(t)-G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[((\hat{P}_{20})^{(3)}+G_{21}^0)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)}+(\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0+\int_0^t\left[(a_{24})^{(4)}\left(G_{25}^0+(\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right]ds_{(24)}=$ $\left(1+(a_{24})^{(4)}t\right)G_{25}^0+\frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t}-1\right)$	173
From which it follows that $(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[((\hat{P}_{24})^{(4)}+G_{25}^0)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176
From which it follows that $(G_{32}(t) - G_{32}^0) e^{-(\hat{M}_{32})^{(6)} t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left[\left((\hat{P}_{32})^{(6)} + G_{33}^0 \right) e^{\left(-\frac{(\hat{P}_{32})^{(6)} + G_{33}^0}{G_{33}^0} \right)} + (\hat{P}_{32})^{(6)} \right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for G_{25} , $G_{26}, T_{24}, T_{25}, T_{26}$	177
(x) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} \left(G_{37}^0 + (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} s_{(36)}} \right) \right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)} t\right) G_{37}^0 + \frac{(a_{36})^{(7)} (\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left(e^{(\hat{M}_{36})^{(7)} t} - 1 \right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0) e^{-(\hat{M}_{36})^{(7)} t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left[\left((\hat{P}_{36})^{(7)} + G_{37}^0 \right) e^{\left(-\frac{(\hat{P}_{36})^{(7)} + G_{37}^0}{G_{37}^0} \right)} + (\hat{P}_{36})^{(7)} \right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}} \right) \right] ds_{(40)} =$	180

$\left(1+(a_{40})^{(8)}t\right)G_{41}^{0}+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	
From which it follows that $(G_{40}(t)-G_{40}^{0})e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^{0}\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^{0}}{G_{41}^{0}}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8. Analogous inequalities hold also for G_{41}, $G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t)\leq G_{44}^{0}+\int_0^t\left[(a_{44})^{(9)}\left(G_{45}^{0}+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right]ds_{(44)}=$ $\left(1+(a_{44})^{(9)}t\right)G_{45}^{0}+\frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$	
From which it follows that $(G_{44}(t)-G_{44}^{0})e^{-(\hat{M}_{44})^{(9)}t}\leq\frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^{0}\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^{0}}{G_{45}^{0}}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9. Analogous inequalities hold also for G_{45}, $G_{46}, T_{44}, T_{45}, T_{46}$	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)}+\left((\hat{P}_{13})^{(1)}+G_j^{0}\right)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^{0}}{G_j^{0}}\right)}\right]\leq(\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{Q}_{13})^{(1)}+T_j^{0}\right)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^{0}}{T_j^{0}}\right)}+(\hat{Q}_{13})^{(1)}\right]\leq(\hat{Q}_{13})^{(1)}$	184
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The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left(\left(G^{(1)},T^{(1)}\right),\left(G^{(2)},T^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{13})^{(1)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{13})^{(1)}t}\}$	185

Indeed if we denote

Definition of $\tilde{G}, \tilde{T}$: $(\tilde{G}, \tilde{T}) = \mathcal{A}^{(1)}(G, T)$

It results

$|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{13})^{(1)} |G_{14}^{(1)} - G_{14}^{(2)}| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} \, ds_{(13)} +$

$\int_0^t \{(a_{13}')^{(1)} |G_{13}^{(1)} - G_{13}^{(2)}| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} +$

$(a_{13}'')^{(1)} (T_{14}^{(1)}, s_{(13)}) |G_{13}^{(1)} - G_{13}^{(2)}| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} +$

$G_{13}^{(2)} |(a_{13}'')^{(1)} (T_{14}^{(1)}, s_{(13)}) - (a_{13}'')^{(1)} (T_{14}^{(2)}, s_{(13)})| \; e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} \} ds_{(13)}$

Where $s_{(13)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses it follows

$|G^{(1)} - G^{(2)}| e^{-(\widehat{M}_{13})^{(1)} t} \leq$ 186

$\frac{1}{(\widehat{M}_{13})^{(1)}} \left((a_{13})^{(1)} + (a_{13}')^{(1)} + (\widehat{A}_{13})^{(1)} + (\widehat{P}_{13})^{(1)} (\widehat{k}_{13})^{(1)} \right) d\left((G^{(1)}, T^{(1)}; \, G^{(2)}, T^{(2)}) \right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 1: The fact that we supposed $(a_{13}'')^{(1)}$ and $(b_{13}'')^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{13})^{(1)} e^{(\widehat{M}_{13})^{(1)} t}$ *and* $(\widehat{Q}_{13})^{(1)} e^{(\widehat{M}_{13})^{(1)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(1)}$ and $(b_i'')^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(\text{and not on } t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 19 to 24 it results

$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(1)} - (a_i'')^{(1)} (T_{14}(s_{(13)}), s_{(13)})\} ds_{(13)} \right]} \geq 0$

$T_i(t) \geq T_i^0 e^{(-(b_i')^{(1)} t)} > 0$ for t > 0

Definition of $((\widehat{M}_{13})^{(1)})_1, ((\widehat{M}_{13})^{(1)})_2$ *and* $((\widehat{M}_{13})^{(1)})_3$: 187

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$G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \leq ((\widehat{M}_{13})^{(1)})_1 - (a_{14}')^{(1)} G_{14}$ and by integrating

$G_{14} \leq ((\widehat{M}_{13})^{(1)})_2 = G_{14}^0 + 2(a_{14})^{(1)} ((\widehat{M}_{13})^{(1)})_1 / (a_{14}')^{(1)}$

In the same way , one can obtain $G_{15} \leq \left((\widehat{M}_{13})^{(1)}\right)_3 = G_{15}^0 + 2(a_{15})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_2/(a_{15}^{'})^{(1)}$ If G_{14} or G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.	
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$\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[(\hat{P}_{16})^{(2)} + \left((\hat{P}_{16})^{(2)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{16})^{(2)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{16})^{(2)}$	191
$\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{Q}_{16})^{(2)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{16})^{(2)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{16})^{(2)}\right] \leq (\hat{Q}_{16})^{(2)}$	192
In order that the operator $\mathcal{A}^{(2)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	193
The operator $\mathcal{A}^{(2)}$ is a contraction with respect to the metric $d\left(\left((G_{19})^{(1)},(T_{19})^{(1)}\right),\left((G_{19})^{(2)},(T_{19})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{16})^{(2)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{16})^{(2)}t}\}$	194

Indeed if we denote **Definition of** $\widetilde{G_{19}},\widetilde{T_{19}}$: $\left(\widetilde{G_{19}},\widetilde{T_{19}}\right)=\mathcal{A}^{(2)}(G_{19},T_{19})$	195
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Indeed if we denote **Definition of** $\widetilde{G_{23}}, \widetilde{T_{23}}$:$\left(\widetilde{(G_{23})}, \widetilde{(T_{23})} \right) = \mathcal{A}^{(3)}\left((G_{23}),(T_{23})\right)$	212
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Indeed if we denote **Definition of** $\widetilde{(G_{27})}, \widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})}, \widetilde{(T_{27})} \right) = \mathcal{A}^{(4)}((G_{27}), (T_{27}))$ It results $\left|\tilde{G}_{24}^{(1)} - \tilde{G}_i^{(2)}\right| \le \int_0^t (a_{24})^{(4)} \left|G_{25}^{(1)} - G_{25}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \, ds_{(24)} +$ $\int_0^t \{(a'_{24})^{(4)} \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} +$ $(a''_{24})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right)\left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} +$ $G_{24}^{(2)} \left|(a''_{24})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right) - (a''_{24})^{(4)}\left(T_{25}^{(2)}, s_{(24)}\right)\right| \; e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \} ds_{(24)}$ Where $s_{(24)}$ represents integrand that is integrated over the interval $[0, t]$ From the hypotheses on Equations it follows	
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$\frac{(a_i)^{(8)}}{(\widehat{M}_{40})^{(8)}}\left[(\widehat{P}_{40})^{(8)} + \left((\widehat{P}_{40})^{(8)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{40})^{(8)}$	267
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **<u>Definition of</u>** $\widetilde{(G_{43})},\widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})},\widetilde{(T_{43})}\right)=\mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results $\left\|\tilde{G}_{40}^{(1)}-\tilde{G}_i^{(2)}\right\|\leq\int_0^t(a_{40})^{(8)}\left\|G_{41}^{(1)}-G_{41}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\,ds_{(40)}+$ $\int_0^t\{(a'_{40})^{(8)}\left\|G_{40}^{(1)}-G_{40}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{-(\hat{M}_{40})^{(8)}s_{(40)}}+$ $(a''_{40})^{(8)}\left(T_{41}^{(1)},s_{(40)}\right)\left\|G_{40}^{(1)}-G_{40}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}+$ $G_{40}^{(2)}\|(a''_{40})^{(8)}\left(T_{41}^{(1)},s_{(40)}\right)-(a''_{40})^{(8)}\left(T_{41}^{(2)},s_{(40)}\right)\|\ e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\}ds_{(40)}$	271
Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
$\left\|(G_{43})^{(1)}-(G_{43})^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}t}\leq$ $\frac{1}{(\hat{M}_{40})^{(8)}}\left((a_{40})^{(8)}+(a'_{40})^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}\right)d\left(\left((G_{43})^{(1)},(T_{43})^{(1)};\ (G_{43})^{(2)},(T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
<u>Remark 36:</u> The fact that we supposed $(a''_{40})^{(8)}$ and $(b''_{40})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ *and* $(\hat{Q}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(8)}$ and $(b''_i)^{(8)}, i=40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
<u>Remark 37</u> There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$	275

it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(8)}-(a_i^{''})^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(8)}t)} > 0$ for $t > 0$	
Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}^{'})^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}^{'})^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}^{'})^{(8)}$ If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	276
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(8)}((G_{43})(t),t)) = (b_{41}^{'})^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i^{''})^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}\,(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}^{''})^{(8)}\big((G_{43})(t), t(t), t\big) = (b_{42}^{'})^{(8)}$	279
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have	279 A

$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)}+((\widehat{P}_{44})^{(9)}+G_j^0)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right]\leq(\widehat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[((\widehat{Q}_{44})^{(9)}+T_j^0)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)}+(\widehat{Q}_{44})^{(9)}\right]\leq(\widehat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\widehat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\widehat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})}:(\widetilde{(G_{47})},\widetilde{(T_{47})})=\mathcal{A}^{(9)}((G_{47}),(T_{47}))$ It results $\lvert\tilde{G}_{44}^{(1)}-\tilde{G}_i^{(2)}\rvert\leq\int_0^t(a_{44})^{(9)}\lvert G_{45}^{(1)}-G_{45}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}ds_{(44)}+$ $\int_0^t\{(a'_{44})^{(9)}\lvert G_{44}^{(1)}-G_{44}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}+$ $(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})\lvert G_{44}^{(1)}-G_{44}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}+$ $G_{44}^{(2)}\lvert(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})-(a''_{44})^{(9)}(T_{45}^{(2)},s_{(44)})\rvert\ e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$ Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on 45,46,47,28 and 29 it follows	
$\lvert(G_{47})^{(1)}-G^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}t}\leq$ $\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)}+(a'_{44})^{(9)}+(\widehat{A}_{44})^{(9)}+(\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)})\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows	
Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i=44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	
Remark 42: There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$	

From 99 to 44 it results

$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}\left((G_{47})(t), t\right)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}\left((G_{47})(t), t\right) < \varepsilon_9, T_{44}\,(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}\left((G_{47})(t), t\right) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G,t) - (b''_{14})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if \ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)}, \ if \ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)}, \ if \ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if \ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if \ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})} \left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t} \right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq \right.$ $\left. \frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a'_{15})^{(1)})} [e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}] + G_{15}^0 e^{-(a'_{15})^{(1)}t} \right)$	286

$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(\mathrm{T}_{17}, t) + (a_{17}'')^{(2)}(\mathrm{T}_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\big((G_{19}), t\big) - (b_{17}'')^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\big(u^{(2)}\big)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \; \boldsymbol{if} \; (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if} \; (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \; \boldsymbol{if} \; (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if} \; (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}, \; \boldsymbol{if} \; (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)} t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)} t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})}\left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)} t}\right] + G_{18}^0 e^{-(S_2)^{(2)} t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a'_{18})^{(2)})}\left[e^{(S_1)^{(2)} t} - e^{-(a'_{18})^{(2)} t}\right] + G_{18}^0 e^{-(a'_{18})^{(2)} t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)} t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)} t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b'_{18})^{(2)})}\left[e^{(R_1)^{(2)} t} - e^{-(b'_{18})^{(2)} t}\right] + T_{18}^0 e^{-(b'_{18})^{(2)} t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)} + (r_{16})^{(2)} + (R_2)^{(2)})}\left[e^{((R_1)^{(2)} + (r_{16})^{(2)})t} - e^{-(R_2)^{(2)} t}\right] + T_{18}^0 e^{-(R_2)^{(2)} t}$	315
<u>**Definition of**</u> $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a'_{16})^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},\ \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},\ \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
<u>**Behavior of the solutions of equation**</u> <u>**Theorem:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}\big((G_{27}), t\big) - (b_{25}'')^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
<u>**Definition of**</u> $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations	329

$(a_{25})^{(4)}\left(v^{(4)}\right)^2+(\sigma_1)^{(4)}v^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	
Definition of $(\bar{v}_1)^{(4)},,(\bar{v}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{v}_1)^{(4)}>0\,,(\bar{v}_2)^{(4)}<0$ and respectively $(\bar{u}_1)^{(4)}>0\,,(\bar{u}_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(v^{(4)}\right)^2+(\sigma_2)^{(4)}v^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(\nu_0)^{(4)},(m_1)^{(4)}=(\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)}<(\nu_1)^{(4)}$ $(m_2)^{(4)}=(\nu_1)^{(4)},(m_1)^{(4)}=(\bar{\nu}_1)^{(4)},\boldsymbol{if}\ (\nu_4)^{(4)}<(\nu_0)^{(4)}<(\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(\nu_4)^{(4)},(m_1)^{(4)}=(\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)}<(\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar{u}_1)^{(4)},\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)}=\frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(u_0)^{(4)},\boldsymbol{if}\ (\bar{u}_1)^{(4)}<(u_0)^{(4)}$ where $(u_1)^{(4)},(\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t}\leq G_{24}(t)\leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}}G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t}\leq G_{25}(t)\leq\frac{1}{(m_2)^{(4)}}G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t}-e^{-(S_2)^{(4)}t}\right]+G_{26}^0 e^{-(S_2)^{(4)}t}\leq G_{26}(t)\leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}}$	
$\frac{1}{(\mu_1)^{(4)}}T_{24}^0 e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq\frac{1}{(\mu_2)^{(4)}}T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}\left((R_1)^{(4)}-(b_{26}')^{(4)}\right)}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t}\leq T_{26}(t)\leq$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}')^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}')^{(4)}$ $(R_2)^{(4)}=(b_{26}')^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\leq-(a_{28}')^{(5)}+(a_{29}')^{(5)}-(a_{28}'')^{(5)}(T_{29},t)+(a_{29}'')^{(5)}(T_{29},t)\leq-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\leq-(b_{28}')^{(5)}+(b_{29}')^{(5)}-(b_{28}'')^{(5)}((G_{31}),t)-(b_{29}'')^{(5)}((G_{31}),t)\leq-(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},,(\bar{\nu}_2)^{(5)},(\bar{u}_1)^{(5)},(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)}>0,(\bar{\nu}_2)^{(5)}<0$ and respectively $(\bar{u}_1)^{(5)}>0,(\bar{u}_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar{\nu}_1)^{(5)},\boldsymbol{if}\ (\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}$, $\boldsymbol{if}$ $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, $\boldsymbol{if}$ $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b'_{30})^{(5)}t}\right] + T_{30}^0 e^{-(b'_{30})^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a'_{28})^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b'_{28})^{(5)}$ $(R_2)^{(5)} = (b'_{30})^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33},t) + (a''_{33})^{(6)}(T_{33},t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right) - (b''_{33})^{(6)}\left((G_{35}),t\right) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \; \boldsymbol{if} \; (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \; (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \; \boldsymbol{if} \; (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if} \; (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \; (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{\left((S_1)^{(6)} - (p_{32})^{(6)}\right)t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{\left((S_1)^{(6)} - (p_{32})^{(6)}\right)t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}\left((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)}\right)} \left[e^{\left((S_1)^{(6)} - (p_{32})^{(6)}\right)t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$	370

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$

$(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$

$(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$

Behavior of the solutions of equation 371

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$:

$(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying

$-(\sigma_2)^{(8)} \le -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \le -(\sigma_1)^{(8)}$

$-(\tau_2)^{(8)} \le -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \le -(\tau_1)^{(8)}$

Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: 372

By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$
and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and

Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$:

By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the

roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$

and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$

Definition of $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:-

If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by

$(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)} < (\nu_1)^{(8)}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)},$ ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$,
and $\boxed{(\nu_0)^{(8)} = \frac{G^0_{40}}{G^0_{41}}}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},$ ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}^{'})^{(8)})}[e^{(S_1)^{(8)}t} - e^{-(a_{42}^{'})^{(8)}t}] + G_{42}^0 e^{-(a_{42}^{'})^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}^{'})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}^{'})^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}^{'})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>Definition of</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}^{'})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}^{'})^{(8)}$ $(R_2)^{(8)} = (b_{42}^{'})^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$	
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if}\ (\nu_0)^{(9)} < (\nu_1)^{(9)}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if}\ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$, and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$	
and analogously $(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if}\ (u_0)^{(9)} < (u_1)^{(9)}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if}\ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$, and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if}\ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively	
Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	

$($

$$\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0 e^{-(S_2)^{(9)}t}\leq G_{46}(t)\leq$$

$$\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t}-e^{-(a_{46}')^{(9)}t}]+\ G_{46}^0 e^{-(a_{46}')^{(9)}t})$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}}T_{44}^0 e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq\frac{1}{(\mu_2)^{(9)}}T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b_{46}')^{(9)}t}\right]+T_{46}^0 e^{-(b_{46}')^{(9)}t}\leq T_{46}(t)\leq$$

$$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)},(S_2)^{(9)},(R_1)^{(9)},(R_2)^{(9)}$:-

Where $(S_1)^{(9)}=(a_{44})^{(9)}(m_2)^{(9)}-(a_{44}')^{(9)}$

$(S_2)^{(9)}=(a_{46})^{(9)}-(p_{46})^{(9)}$

$(R_1)^{(9)}=(b_{44})^{(9)}(\mu_2)^{(9)}-(b_{44}')^{(9)}$

$(R_2)^{(9)}=(b_{46}')^{(9)}-(r_{46})^{(9)}$

Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have	386

Definition of $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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In the same manner , we get	391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)}=\frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
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Proof : From global equations we obtain	398

$$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$$

Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ 399

It follows

$$-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$$

From which one obtains 400

For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$

$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$$

Definition of $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \le \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \le \nu^{(4)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \le (\bar{\nu}_1)^{(4)} \le \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \le \nu^{(4)}(t) \le \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \le \nu^{(4)}(t) \le (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \le u^{(4)}(t) \le (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \le \frac{d\nu^{(5)}}{dt} \le -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right) t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right) t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right) t\right]}}{5 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right) t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right) t\right]}}{1 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right) t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right) t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right) t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right) t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right) t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}$, $\boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$**, and definition of** $(u_0)^{(5)}$.	
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ **<u>Definition of</u>** $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains **<u>Definition of</u>** $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G^0_{36}}{G^0_{37}}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **<u>Definition of</u>** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
<u>Definition of</u> $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **<u>Particular case :</u>** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \le \frac{d\nu^{(8)}}{dt} \le -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \ge \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \le \nu^{(8)}(t) \le (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \le \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \le \nu^{(8)}(t) \le (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \le \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \le \nu^{(8)}(t) \le$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \le (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \le (\bar{\nu}_1)^{(8)} \le \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \le \nu^{(8)}(t) \le \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \le (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:-	424

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

with $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ *with* $(p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ *with* $(p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ *with* $(p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ *with* $(p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

<u>**Theorem**</u> If $(a_i'')^{(6)} and\ (b_i'')^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}')^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}')^{(6)}(r_{33})^{(6)} - (b_{33}')^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
<u>**Theorem**</u> **:** If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
<u>**Theorem**</u> **:** If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
<u>**Theorem**</u> **:** If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} \ = \ 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} \ = \ 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} \ = \ 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} \ = \ 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} \ = \ 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} \ = \ 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} \ = \ 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} \ = \ 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} \ = \ 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} \ = \ 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} \ = \ 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} \ = \ 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} \ = \ 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} \ = \ 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} \ = \ 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} \ = \ 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} \ = \ 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} \ = \ 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} \ = \ 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} \ = \ 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} \ = \ 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27}))\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}((G_{27}))\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27}))\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (x) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) +$	486

$(a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)} G_{14}}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)} G_{14}}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)} G_{17}}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)} G_{17}}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	
Definition and uniqueness of T_{37}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$	500
Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right]+(b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right]+(b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23})=(b_{20}')^{(3)}(b_{21}')^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23})+(b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right]+(b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27})=(b_{24}')^{(4)}(b_{25}')^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27})+(b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right]+(b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31})=(b_{28}')^{(5)}(b_{29}')^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31})+(b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right]+(b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35})=(b_{32}')^{(6)}(b_{33}')^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35})+(b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right]+(b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*})=0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39})=(b_{36}')^{(7)}(b_{37}')^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39})+(b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right]+(b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*})=0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi({G_{43}}^*) = 0$	
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{45} such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G^*_{14} given by $\varphi(G^*) = 0$, T^*_{14} given by $f(T^*_{14}) = 0$ and $G^*_{13} = \frac{(a_{13})^{(1)}G^*_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G^*_{15} = \frac{(a_{15})^{(1)}G^*_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$ $T^*_{13} = \frac{(b_{13})^{(1)}T^*_{14}}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T^*_{15} = \frac{(b_{15})^{(1)}T^*_{14}}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G^*_{17} given by $\varphi((G_{19})^*) = 0$, T^*_{17} given by $f(T^*_{17}) = 0$ and	512
$G^*_{16} = \frac{(a_{16})^{(2)}G^*_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G^*_{18} = \frac{(a_{18})^{(2)}G^*_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	513
$T^*_{16} = \frac{(b_{16})^{(2)}T^*_{17}}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T^*_{18} = \frac{(b_{18})^{(2)}T^*_{17}}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G^*_{21} given by $\varphi((G_{23})^*) = 0$, T^*_{21} given by $f(T^*_{21}) = 0$ and $G^*_{20} = \frac{(a_{20})^{(3)}G^*_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G^*_{22} = \frac{(a_{22})^{(3)}G^*_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$ $T^*_{20} = \frac{(b_{20})^{(3)}T^*_{21}}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}({G_{23}}^*)]}$, $T^*_{22} = \frac{(b_{22})^{(3)}T^*_{21}}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}({G_{23}}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*)=0$, T_{29}^* given by $f(T_{29}^*)=0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*)=0$, T_{33}^* given by $f(T_{33}^*)=0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*)=0$, T_{37}^* given by $f(T_{37}^*)=0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*)=0$, T_{41}^* given by $f(T_{41}^*)=0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^*)]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)}T_{41}^*}{[(b_{40}')^{(8)}-(b_{40}'')^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)}T_{41}^*}{[(b_{42}')^{(8)}-(b_{42}'')^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)}G_{45}^*}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)}G_{45}^*}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)}T_{45}^*}{[(b_{44}')^{(9)}-(b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)}T_{45}^*}{[(b_{46}')^{(9)}-(b_{46}'')^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)}G_{13}^*\mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)}G_{14}^*\mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)}G_{15}^*\mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)}T_{13}^*\mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)}T_{14}^*\mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)}T_{15}^*\mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*}) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}\left((G_{35})^{*}\right) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{37})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b''_i)^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a'_{36})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a'_{37})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b''_i)^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(9)}$ *and* $(b''_i)^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a''_{45})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b''_i)^{(9)}}{\partial G_j}((G_{47})^{*}) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a'_{44})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a'_{45})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a'_{46})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b'_{44})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b'_{45})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b'_{46})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b'_{15})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a'_{15})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)} + (a'_{14})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*} + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$$

$$+$$

$$\left((\lambda)^{(2)} + (b_{18}')^{(2)} - (r_{18})^{(2)}\right)\{\left((\lambda)^{(2)} + (a_{18}')^{(2)} + (p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^* + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)\right]$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^*\right)$$

$$+\left(\left((\lambda)^{(2)} + (a_{17}')^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^* + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^*\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^*\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}')^{(2)} + (b_{17}')^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^* + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^*\right)\} = 0$$

$$+$$

$$\left((\lambda)^{(3)} + (b_{22}')^{(3)} - (r_{22})^{(3)}\right)\{\left((\lambda)^{(3)} + (a_{22}')^{(3)} + (p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)} + (a_{20}')^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^* + (a_{21})^{(3)}(q_{20})^{(3)}G_{20}^*\right)\right]$$

$$\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^* + (b_{21})^{(3)}s_{(20),(21)}T_{21}^*\right)$$

$$+\left(\left((\lambda)^{(3)} + (a_{21}')^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^* + (a_{20})^{(3)}(q_{21})^{(1)}G_{21}^*\right)$$

$$\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^* + (b_{21})^{(3)}s_{(20),(20)}T_{20}^*\right)$$

$\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2 + \left((b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\} = 0$ +	
$\left((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\{\left((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$\left((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\{\left((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(\left((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$\left(((\lambda)^{(5)})^2 + ((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}) (\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^2 + ((b'_{28})^{(5)} + (b'_{29})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}) (\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^2 + ((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}) (\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)} + (a'_{28})^{(5)} + (p_{28})^{(5)}) \left((a_{30})^{(5)}(q_{29})^{(5)}G^*_{29} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G^*_{28}\right)$ $\left(((\lambda)^{(5)} + (b'_{28})^{(5)} - (r_{28})^{(5)})s_{(29),(30)}T^*_{29} + (b_{29})^{(5)}s_{(28),(30)}T^*_{28}\right)\} = 0$ +	
$((\lambda)^{(6)} + (b'_{34})^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a'_{34})^{(6)} + (p_{34})^{(6)})$ $\left[\left(((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)})(q_{33})^{(6)}G^*_{33} + (a_{33})^{(6)}(q_{32})^{(6)}G^*_{32}\right)\right]$ $\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)})s_{(33),(33)}T^*_{33} + (b_{33})^{(6)}s_{(32),(33)}T^*_{33}\right)$ $+\left(((\lambda)^{(6)} + (a'_{33})^{(6)} + (p_{33})^{(6)})(q_{32})^{(6)}G^*_{32} + (a_{32})^{(6)}(q_{33})^{(6)}G^*_{33}\right)$ $\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)})s_{(33),(32)}T^*_{33} + (b_{33})^{(6)}s_{(32),(32)}T^*_{32}\right)$ $\left(((\lambda)^{(6)})^2 + ((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}) (\lambda)^{(6)}\right)$ $\left(((\lambda)^{(6)})^2 + ((b'_{32})^{(6)} + (b'_{33})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}) (\lambda)^{(6)}\right)$ $+\left(((\lambda)^{(6)})^2 + ((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}) (\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$ $+((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)}) \left((a_{34})^{(6)}(q_{33})^{(6)}G^*_{33} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G^*_{32}\right)$ $\left(((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)})s_{(33),(34)}T^*_{33} + (b_{33})^{(6)}s_{(32),(34)}T^*_{32}\right)\} = 0$ + $((\lambda)^{(7)} + (b'_{38})^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a'_{38})^{(7)} + (p_{38})^{(7)})$ $\left[\left(((\lambda)^{(7)} + (a'_{36})^{(7)} + (p_{36})^{(7)})(q_{37})^{(7)}G^*_{37} + (a_{37})^{(7)}(q_{36})^{(7)}G^*_{36}\right)\right]$ $\left(((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)})s_{(37),(37)}T^*_{37} + (b_{37})^{(7)}s_{(36),(37)}T^*_{37}\right)$ $+\left(((\lambda)^{(7)} + (a'_{37})^{(7)} + (p_{37})^{(7)})(q_{36})^{(7)}G^*_{36} + (a_{36})^{(7)}(q_{37})^{(7)}G^*_{37}\right)$ $\left(((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)})s_{(37),(36)}T^*_{37} + (b_{37})^{(7)}s_{(36),(36)}T^*_{36}\right)$	

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right) (q_{38})^{(7)} G_{38}$$

$$+((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)}) \left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)})s_{(37),(38)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\} = 0$$

+

$$((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right) (q_{42})^{(8)} G_{42}$$

$$+((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}) \left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$$

+

$$((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION TWENTY FIVE

'Topological Defects' That May Have Been Formed At Phase Transitions

INTRODUCTION—VARIABLES USED

Cosmic strings M B Hindmarsh and T W B Kibble Reports on Progress in Physics, Volume 58, and Number 5

(1) They are 'topological defects' that may have been formed at phase transitions in the very early history of the Universe, analogous to (e&eb) those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals.

(2) In this review, authors describe what they are, why they have been hypothesized and what their cosmological implications would be. The relevant background from the standard models of particle physics and cosmology is described in section 1. In section 2, we review the idea of symmetry breaking (e) in field theories, and show how the defects formed is constrained by (e&eb) the topology of the manifold of (e) degenerate vacuum states.

(3) They also discuss the different types of cosmic strings that can appear in (eb) different field theories. Section 3 is devoted to the dynamics of cosmic strings, and section 4 to their interaction with other fields. The formation and evolution of cosmic strings in the early Universe is the subject of section 5, while section 6 deals with their observational implications. Finally, the present status of the theory is reviewed in section 7.

A Model for Lightcone Fluctuations due to Stress Tensor Fluctuations C.H.G. Bessa, V.A. De Lorenci,

L.H. Ford, C.C.H. Ribeiro

(4) Authors study a model for quantum lightcone fluctuations in (eb) which vacuum fluctuations of the electric field and of the squared electric field in (eb) a nonlinear dielectric material produce (eb) variations in the flight times of (e) probe pulses.

(5) When this material has a non-zero third order polarizability, (eb) the flight time variations arise from (e) squared electric field fluctuations, and are (=) analogous to effects expected when (e) the stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations.

(6) Authors also discuss the dependence of the squared electric field fluctuations upon (e&eb) the geometry of the material, which in turn determines (eb) a sampling function for (e) averaging the squared electric field along the path of the pulse.

(7) This allows (eb) us to estimate the probability of especially large fluctuations, which is (=) a measure of the probability distribution for quantum stress tensor fluctuations. Subjects: General Relativity and Quantum Cosmology (gr-qc); High Energy Physics - Theory (hep-th); Quantum Physics (quant-ph) Cite as: arXiv:1602.03857 [gr-qc] (or arXiv:1602.03857v1 [gr-qc] for this version)

NOTATION

Module One

They are 'topological defects' that may have been formed at phase transitions in the very early history of the Universe, analogous to (e&eb) those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals

G_{13} : Category one of **'topological defects' that may have been formed at phase transitions in the very early history of the Universe;** those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of those found in some condensed matter systems-vortex lines in liquid helium, flux tubes in type-II superconductors, or disclination lines in liquid crystals **; 'topological defects' that may have been formed at phase transitions in the very early history of the Universe,**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

In this review, authors describe what they are, why they have been hypothesized and what their cosmological implications would be.

The relevant background from the standard models of particle physics and cosmology is described in section 1.

In section 2, we review the idea of symmetry breaking (e) in field theories, and show how the defects formed is constrained by (e&eb) the topology of the manifold of (e) degenerate vacuum states

G_{16} : Category one of **symmetry breaking;** field theories, and show how the defects formed is constrained by (e&eb) the topology of the manifold of (e) degenerate vacuum states

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of field theories, and show how the defects formed is constrained by (e&eb) the topology of the manifold of (e) degenerate vacuum states; **symmetry breaking**

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

In section 2, we review the idea of symmetry breaking in field theories, and show how the defects formed is constrained by (e&eb) the topology of the manifold of (e) degenerate vacuum states

G_{20} : Category one of **symmetry breaking in field theories, the defects formed;** topology of the manifold of (e) degenerate vacuum states

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of topology of the manifold of (e) degenerate vacuum states; **symmetry breaking in field theories, the defects formed**

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

In section 2, we review the idea of symmetry breaking in field theories, and show how the defects formed is constrained by the topology of the manifold of (e) degenerate vacuum states

G_{24} : Category one of **symmetry breaking in field theories, and show how the defects formed is constrained by the topology of the manifold;** degenerate vacuum states

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of degenerate vacuum states **;symmetry breaking in field theories, and show how the defects formed is constrained by the topology of the manifold**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

Authors study a model for quantum lightcone fluctuations in (eb) which vacuum fluctuations of the electric field and of the squared electric field in (eb) a nonlinear dielectric material produce (eb) variations in the flight times of (e) probe pulses

G_{28} : Category one of **quantum lightcone fluctuations;** vacuum fluctuations of the electric field and of the squared electric field in (eb) a nonlinear dielectric material produce (eb) variations in the flight times of (e) probe pulses

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of vacuum fluctuations of the electric field and of the squared electric field in (eb) a nonlinear dielectric material produce (eb) variations in the flight times of (e) probe pulses **;quantum lightcone fluctuations**

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

Authors study a model for quantum lightcone fluctuations in which vacuum fluctuations of the electric field and of the squared electric field in (eb) a nonlinear dielectric material produce (eb) variations in the flight times of (e) probe pulses

G_{32} : Category one of **quantum lightcone fluctuations in which vacuum fluctuations of the electric field and of the squared electric field;** nonlinear dielectric material produce (eb) variations in the flight times of (e) probe pulses

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of nonlinear dielectric material produce (eb) variations in the flight times of (e) probe pulses; **quantum lightcone fluctuations in which vacuum fluctuations of the electric field and of the squared electric field**

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

Authors study a model for quantum lightcone fluctuations in which vacuum fluctuations of the electric field and of the squared electric field in a nonlinear dielectric material produce (eb) variations in the flight times of (e) probe pulses

G_{36} : Category one of quantum lightcone fluctuations in which vacuum fluctuations of the electric field and of the squared electric field in a nonlinear dielectric material

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of variations in the flight times of probe pulses

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

When this material has a non-zero third order polarizability, (eb) the flight time variations arise from (e) squared electric field fluctuations, and are (=) analogous to effects expected when (e) the stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations

G_{40} : Category one of non-zero third order polarizability

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of flight time variations arise from (e) squared electric field fluctuations, and are (=) analogous to effects expected when (e) the stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

When this material has a non-zero third order polarizability the flight time variations arise from (e) squared electric field fluctuations, and are (=) analogous to effects expected when (e) the stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations

G_{44} : Category one of squared electric field fluctuations, and are (=) analogous to effects expected when (e) the stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of material has a non-zero third order polarizability the flight time variations arise

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$	

$(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}, \ (b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$ $, (a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)} \ (a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t)\right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t)\right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t)\right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t)\right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t)\right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}, t)\right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}, t)\right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\big((G_{19}), t\big)\right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\big((G_{19}), t\big)\right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\big((G_{19}), t\big)\right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\big((G_{19}), t\big) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}, t)\right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21}, t)\right] G_{21}$	14

$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a_{22}')^{(3)} + (a_{22}'')^{(3)} (T_{21}, t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b_{20}')^{(3)} - (b_{20}'')^{(3)} (G_{23}, t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b_{21}')^{(3)} - (b_{21}'')^{(3)} (G_{23}, t) \right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b_{22}')^{(3)} - (b_{22}'')^{(3)} (G_{23}, t) \right] T_{22}$	18
$+(a_{20}'')^{(3)} (T_{21}, t) =$ First augmentation factor	
$-(b_{20}'')^{(3)} (G_{23}, t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a_{24}')^{(4)} + (a_{24}'')^{(4)} (T_{25}, t) \right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)} (T_{25}, t) \right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)} (T_{25}, t) \right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)} \left((G_{27}), t \right) \right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)} \left((G_{27}), t \right) \right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b_{26}')^{(4)} - (b_{26}'')^{(4)} \left((G_{27}), t \right) \right] T_{26}$	24
$+(a_{24}'')^{(4)} (T_{25}, t) =$ **First augmentation factor**	
$-(b_{24}'')^{(4)} \left((G_{27}), t \right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a_{28}')^{(5)} + (a_{28}'')^{(5)} (T_{29}, t) \right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a_{29}')^{(5)} + (a_{29}'')^{(5)} (T_{29}, t) \right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a_{30}')^{(5)} + (a_{30}'')^{(5)} (T_{29}, t) \right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b_{28}')^{(5)} - (b_{28}'')^{(5)} \left((G_{31}), t \right) \right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b_{29}')^{(5)} - (b_{29}'')^{(5)} \left((G_{31}), t \right) \right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b_{30}')^{(5)} - (b_{30}'')^{(5)} \left((G_{31}), t \right) \right] T_{30}$	30
$+(a_{28}'')^{(5)} (T_{29}, t) =$ **First augmentation factor**	
$-(b_{28}'')^{(5)} \left((G_{31}), t \right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a_{32}')^{(6)} + (a_{32}'')^{(6)} (T_{33}, t) \right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a_{33}')^{(6)} + (a_{33}'')^{(6)} (T_{33}, t) \right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)} (T_{33}, t) \right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}')^{(6)} - (b_{32}'')^{(6)} \left((G_{35}), t \right) \right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}')^{(6)} - (b_{33}'')^{(6)} \left((G_{35}), t \right) \right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}')^{(6)} - (b_{34}'')^{(6)} \left((G_{35}), t \right) \right] T_{34}$	36

$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	38
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	39
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}((G_{39}),t)\right]T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}((G_{39}),t)\right]T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}((G_{39}),t)\right]T_{38}$	42
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}((G_{43}),t)\right]T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}((G_{43}),t)\right]T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}((G_{43}),t)\right]T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}((G_{47}),t)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}((G_{47}),t)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}((G_{47}),t)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}((G_{47}),t) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[\begin{matrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	56

$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\begin{bmatrix}(a_{15}^{'})^{(1)}\boxed{+(a_{15}^{''})^{(1)}(T_{14},t)}\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)}\\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)}\\ \boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)}\boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)}\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{15}$	57
Where $\boxed{(a_{13}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{14}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{15}^{''})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)}\boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)}\boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)}\boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)}\boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\begin{bmatrix}(b_{13}^{'})^{(1)}\boxed{-(b_{13}^{''})^{(1)}(G,t)}\boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)}\boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{36}^{''})^{(7,7,)}(G_{39},t)}\boxed{-(b_{40}^{''})^{(8,8)}(G_{43},t)}\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{13}$	58
$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\begin{bmatrix}(b_{14}^{'})^{(1)}\boxed{-(b_{14}^{''})^{(1)}(G,t)}\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}\boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{37}^{''})^{(7,7,)}(G_{39},t)}\boxed{-(b_{41}^{''})^{(8,8)}(G_{43},t)}\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{14}$	59
$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\begin{bmatrix}(b_{15}^{'})^{(1)}\boxed{-(b_{15}^{''})^{(1)}(G,t)}\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}\boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}\boxed{-(b_{42}^{''})^{(8,8)}(G_{43},t)}\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{15}$	60
Where $\boxed{-(b_{13}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients	

for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{37})^{(7,7,)}(G_{39},t)$, $-(b''_{36})^{(7,7,)}(G_{39},t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8)}(G_{43},t)$ $-(b''_{41})^{(8,8)}(G_{43},t)$ $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17},t) + (a''_{13})^{(1,1,)}(T_{14},t) + (a''_{20})^{(3,3,3)}(T_{21},t) \\ + (a''_{24})^{(4,4,4,4,4)}(T_{25},t) + (a''_{28})^{(5,5,5,5,5)}(T_{29},t) + (a''_{32})^{(6,6,6,6,6)}(T_{33},t) \\ + (a''_{36})^{(7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8)}(T_{41},t) + (a''_{44})^{(9,9)}(T_{45},t) \end{matrix} \right] G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17},t) + (a''_{14})^{(1,1,)}(T_{14},t) + (a''_{21})^{(3,3,3)}(T_{21},t) \\ + (a''_{25})^{(4,4,4,4,4)}(T_{25},t) + (a''_{29})^{(5,5,5,5,5)}(T_{29},t) + (a''_{33})^{(6,6,6,6,6)}(T_{33},t) \\ + (a''_{37})^{(7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8)}(T_{41},t) + (a''_{45})^{(9,9)}(T_{45},t) \end{matrix} \right] G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17},t) + (a''_{15})^{(1,1,)}(T_{14},t) + (a''_{22})^{(3,3,3)}(T_{21},t) \\ + (a''_{26})^{(4,4,4,4,4)}(T_{25},t) + (a''_{30})^{(5,5,5,5,5)}(T_{29},t) + (a''_{34})^{(6,6,6,6,6)}(T_{33},t) \\ + (a''_{38})^{(7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8)}(T_{41},t) + (a''_{46})^{(9,9)}(T_{45},t) \end{matrix} \right] G_{18}$	63
Where $+(a''_{16})^{(2)}(T_{17},t)$, $+(a''_{17})^{(2)}(T_{17},t)$, $+(a''_{18})^{(2)}(T_{17},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,)}(T_{14},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$	68

$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{20}$	70
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{21}$	71
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{22}$	72
$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*	

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$
are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$
are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$
are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$
are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$
are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} & \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} & \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} & \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

$Where$ $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ $are\ first\ detrition\ coefficients$ $for\ category\ 1, 2\ and\ 3$

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ $are\ second\ detrition\ coefficients$ $for\ category\ 1, 2\ and\ 3$

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category\ 1, 2\ and\ 3$

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

$are\ fourth\ detrition\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

$are\ fifth\ detrition\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

$are\ sixth\ detrition\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

$are\ seventh\ detrition\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

$are\ eighth\ detrition\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} & \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} & \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} & \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28} \quad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} & \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} & \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} & \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29} \quad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$$	82
$$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$$	83
$$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3	

$-(b''_{13})^{(1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1)}(G,t)$, $-(b''_{15})^{(1,1,1,1,1,)}(G,t)$ are fourth detrition coefficients for category 1,2, and 3 $-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)$ are fifth detrition coefficients for category 1,2, and 3 $-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1,2, and 3 $-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2, and 3 $-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1,2, and 3 $-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33} - \left[\begin{matrix}(a'_{32})^{(6)} +(a''_{32})^{(6)}(T_{33},t) +(a''_{28})^{(5,5,5)}(T_{29},t) +(a''_{24})^{(4,4,4,)}(T_{25},t) \\ +(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t) +(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t) +(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t) +(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{32}$	85
$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32} - \left[\begin{matrix}(a'_{33})^{(6)} +(a''_{33})^{(6)}(T_{33},t) +(a''_{29})^{(5,5,5)}(T_{29},t) +(a''_{25})^{(4,4,4,)}(T_{25},t) \\ +(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t) +(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t) +(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t) +(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t) +(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{33}$	86
$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33} - \left[\begin{matrix}(a'_{34})^{(6)} +(a''_{34})^{(6)}(T_{33},t) +(a''_{30})^{(5,5,5)}(T_{29},t) +(a''_{26})^{(4,4,4,)}(T_{25},t) \\ +(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t) +(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t) +(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t) +(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t) +(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{34}$	87
$+(a''_{32})^{(6)}(T_{33},t)$, $+(a''_{33})^{(6)}(T_{33},t)$, $+(a''_{34})^{(6)}(T_{33},t)$ *are first augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{28})^{(5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5)}(T_{29},t)$ *are second augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{24})^{(4,4,4,)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,)}(T_{25},t)$ *are third augmentation coefficients for category* 1, 2 *and* 3 $+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)$ - are fourth augmentation coefficients $+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)$ - fifth augmentation coefficients $+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)$ sixth augmentation coefficients $+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)$ seventh augmentation coefficients $+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)$	

Eighth augmentation coefficients $+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\left[\begin{matrix}(b'_{32})^{(6)}-(b''_{32})^{(6)}(G_{35},t)-(b''_{28})^{(5,5,5)}(G_{31},t)-(b''_{24})^{(4,4,4,)}(G_{27},t)\\-(b''_{13})^{(1,1,1,1,1,1)}(G,t)-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)\\-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)\end{matrix}\right]T_{32}$	*88*
$\frac{dT_{33}}{dt}=(b_{33})^{(6)}T_{32}-\left[\begin{matrix}(b'_{33})^{(6)}-(b''_{33})^{(6)}(G_{35},t)-(b''_{29})^{(5,5,5)}(G_{31},t)-(b''_{25})^{(4,4,4,)}(G_{27},t)\\-(b''_{14})^{(1,1,1,1,1,1)}(G,t)-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)\\-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)\end{matrix}\right]T_{33}$	*89*
$\frac{dT_{34}}{dt}=(b_{34})^{(6)}T_{33}-\left[\begin{matrix}(b'_{34})^{(6)}-(b''_{34})^{(6)}(G_{35},t)-(b''_{30})^{(5,5,5)}(G_{31},t)-(b''_{26})^{(4,4,4,)}(G_{27},t)\\-(b''_{15})^{(1,1,1,1,1,1)}(G,t)-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)\\-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)\end{matrix}\right]T_{34}$	*90*
$-(b''_{32})^{(6)}(G_{35},t)$, $-(b''_{33})^{(6)}(G_{35},t)$, $-(b''_{34})^{(6)}(G_{35},t)$ *are first detrition coefficients for category* 1, 2 *and* 3 $-(b''_{28})^{(5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5)}(G_{31},t)$ *are second detrition coefficients for category* 1, 2 *and* 3 $-(b''_{24})^{(4,4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,)}(G_{27},t)$ *are third detrition coefficients for category* 1,2 *and* 3 $-(b''_{13})^{(1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1)}(G,t)$, $-(b''_{15})^{(1,1,1,1,1,1)}(G,t)$ are fourth detrition coefficients for category 1, 2, and 3 $-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)$ are fifth detrition coefficients for category 1, 2, and 3 $-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1, 2, and 3 $-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2, and 3 $-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2, and 3 $-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt}=(a_{36})^{(7)}G_{37}-\left[\begin{matrix}(a'_{36})^{(7)}+(a''_{36})^{(7)}(T_{37},t)+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)\\+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)\\+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)\end{matrix}\right]G_{13}$	*91*

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a_{37}^{'})^{(7)} \boxed{+(a_{37}^{''})^{(7)}(T_{37},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14} \quad (92)$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a_{38}^{'})^{(7)} \boxed{+(a_{38}^{''})^{(7)}(T_{37},t)} \boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \quad (93)$$

Where $\boxed{(a_{36}^{''})^{(7)}(T_{37},t)}$, $\boxed{(a_{37}^{''})^{(7)}(T_{37},t)}$, $\boxed{(a_{38}^{''})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b_{36}^{'})^{(7)} \boxed{-(b_{36}^{''})^{(7)}(G_{39},t)} \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \quad (94)$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b_{37}^{'})^{(7)} \boxed{-(b_{37}^{''})^{(7)}(G_{39},t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	*95*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} & \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \left[\begin{array}{l} (b_{42}^{'})^{(8)} \boxed{-(b_{42}^{''})^{(8)}(G_{43},t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{15}$$

Where $\boxed{-(b_{36}^{''})^{(7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{array}{l} (a_{44}^{'})^{(9)} \boxed{+(a_{44}^{''})^{(9)}(T_{45},t)} \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{array}\right] G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{array}{l} (a_{45}^{'})^{(9)} \boxed{+(a_{45}^{''})^{(9)}(T_{45},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{array}\right] G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b'_i)^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2 \to \infty} (a''_i)^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b''_i)^{(1)} (G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\lvert(a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\rvert \le (\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\ ,\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
<u>Definition of</u> $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)},\ (r_i)^{(1)},i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[\,(a_i)^{(1)}+(a_i')^{(1)}+\ (\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}\,(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[\ (b_i)^{(1)}+(b_i')^{(1)}+\ (\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}\ \ (\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0,\quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
<u>Definition of</u> $(p_i)^{(2)},\ (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t)\le(p_i)^{(2)}\le\left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t)\le\ (r_i)^{(2)}\le(b_i')^{(2)}\le(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}\left((G_{19}),t\right)=\ (r_i)^{(2)}$	105
<u>Definition of</u> $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	

$\|(a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\| \leq (\hat{k}_{16})^{(2)}\|T_{17}-T_{17}'\|e^{-(\hat{M}_{16})^{(2)}t}$	107
$\|(b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\| < (\hat{k}_{16})^{(2)}\|\|(G_{19})-(G_{19})'\|\|e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}$, $\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)}, (r_i)^{(2)}, i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)}+(a_i')^{(2)}+(\hat{A}_{16})^{(2)}+(\hat{P}_{16})^{(2)}(\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)}+(b_i')^{(2)}+(\hat{B}_{16})^{(2)}+(\hat{Q}_{16})^{(2)}(\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0, \quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}$, $(\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21},t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t) \leq (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}(T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}(G_{23},t)= (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)}, (r_i)^{(3)}$ are positive constants and $i=20,21,22$	113

They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}{}',t)-(b_i'')^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23}-G_{23}{}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and$(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}\ ,\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}}<1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[\ (a_i)^{(3)}+(a_i')^{(3)}+\ (\hat{A}_{20})^{(3)}+\ (\hat{P}_{20})^{(3)}\ (\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[\ (b_i)^{(3)}+(b_i')^{(3)}+\ (\hat{B}_{20})^{(3)}+\ (\hat{Q}_{20})^{(3)}\ (\hat{k}_{20})^{(3)}]<1$	116
Where we suppose	
$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)}>0, \quad i,j=24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t)\leq(p_i)^{(4)}\leq(\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}\big((G_{27}),t\big)\leq\ (r_i)^{(4)}\leq(b_i')^{(4)}\leq(\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}\big((G_{27}),t\big)=\ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i=24,25,26}$	118
They satisfy Lipschitz condition:	119

$\lvert(a_i'')^{(4)}(T_{25}',t)-(a_i'')^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i'')^{(4)}((G_{27})',t)-(b_i'')^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and $(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}$, $\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
Definition of $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)}$ *and* $(\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(p_i)^{(4)},(r_i)^{(4)}, i=24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)}+(a_i')^{(4)}+(\hat{A}_{24})^{(4)}+(\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)}+(b_i')^{(4)}+(\hat{B}_{24})^{(4)}+(\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i')^{(5)},(a_i'')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(b_i'')^{(5)}>0, \quad i,j=28,29,30$ The functions $(a_i'')^{(5)},(b_i'')^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t)\leq(p_i)^{(5)}\leq(\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}),t)\leq (r_i)^{(5)}\leq(b_i')^{(5)}\leq(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t)= (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123

They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29}-T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31})-(G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
Definition of $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and\ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}, i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\,(a_i)^{(5)}+(a_i')^{(5)}+\ (\hat{A}_{28})^{(5)}+\ (\hat{P}_{28})^{(5)}\,(\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)}+(b_i')^{(5)}+\ (\hat{B}_{28})^{(5)}+\ (\hat{Q}_{28})^{(5)}\ \ (\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i')^{(6)},(a_i'')^{(6)},(b_i)^{(6)},(b_i')^{(6)},(b_i'')^{(6)}>0,\quad i,j=32,33,34$ The functions $(a_i'')^{(6)},(b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)},\ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t)\leq(p_i)^{(6)}\leq(\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t)\leq\ (r_i)^{(6)}\leq(b_i')^{(6)}\leq(\hat{B}_{32})^{(6)}$	127
$lim_{T_2\to\infty}(a_i'')^{(6)}\,(T_{33},t)=(p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}\left((G_{35}),t\right)=\ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$:	128

Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	
They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(6)}(T_{33}^{'},t) - (a_i^{''})^{(6)}(T_{33},t) \rvert \le (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}^{'} \rvert e^{-(\hat{M}_{32})^{(6)} t}$ $\lvert (b_i^{''})^{(6)}((G_{35})^{'},t) - (b_i^{''})^{(6)}\big((G_{35}),t\big) \rvert < (\hat{k}_{32})^{(6)} \lvert\lvert (G_{35}) - (G_{35})^{'} \rvert\rvert e^{-(\hat{M}_{32})^{(6)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'},t)$ and $(a_i^{''})^{(6)}(T_{33},t)$. $(T_{33}^{'},t)$ and (T_{33},t) are points belonging to the interval $\big[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\big]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>Definition of</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i^{'})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i^{'})^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i^{'})^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(OOOOOO) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (PPPPPP) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37},t) \le (p_i)^{(7)} \le (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39},t) \le \ (r_i)^{(7)} \le (b_i^{'})^{(7)} \le (\hat{B}_{36})^{(7)}$	131
(QQQQQQ) $\lim_{T_2 \to \infty} \ (a_i^{''})^{(7)} \ (T_{37},t) = (p_i)^{(7)}$ *(RRRRRR)* $\lim_{G \to \infty} (b_i^{''})^{(7)} \big((G_{39}),t\big) = \ (r_i)^{(7)}$	132

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}' \rvert e^{-(\hat{M}_{36})^{(7)} t}$ $\lvert(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\rvert < (\hat{k}_{36})^{(7)} \lvert\lvert (G_{39}) - (G_{39})' \rvert\rvert e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (SSSSSS) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (TTTTTT) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i, j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138

$(b_i^{''})^{(8)}((G_{43}),t) \leq (r_i)^{(8)} \leq (b_i^{'})^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i^{''})^{(8)}(T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i^{''})^{(8)}\left((G_{43}),t\right) = (r_i)^{(8)}$	141
<u>Definition of</u> $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}$ are positive constants and $i = 40,41,42$	
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'},t) - (a_i^{''})^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}^{'}\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i^{''})^{(8)}((G_{43})^{'},t) - (b_i^{''})^{(8)}\left((G_{43}),t\right)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})^{'}\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}^{'},t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. $(T_{41}^{'},t)$ and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}$, $\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
<u>Definition of</u> $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i^{'})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i^{'})^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i^{'})^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i^{'})^{(9)}, (a_i^{''})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (b_i^{''})^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$$(a_i^{''})^{(9)}(T_{45}, t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$$

$$(b_i^{''})^{(9)}(G_{47}, t) \leq \ (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$$

$$\lim_{T_2 \to \infty} (a_i^{''})^{(9)}(T_{45}, t) = (p_i)^{(9)}$$

$$\lim_{G \to \infty} (b_i^{''})^{(9)}(G_{47}, t) = \ (r_i)^{(9)}$$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$$|(a_i^{''})^{(9)}(T_{45}^{'}, t) - (a_i^{''})^{(9)}(T_{45}, t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}^{'}|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i^{''})^{(9)}((G_{47})^{'}, t) - (b_i^{''})^{(9)}\big((G_{47}), t\big)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})^{'}||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'}, t)$ and $(a_i^{''})^{(9)}(T_{45}, t)$. $(T_{45}^{'}, t)$ and (T_{45}, t) are points belonging to the interval $\big[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\big]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)}$ *and* $(\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)} + (a_i^{'})^{(9)} + \ (\hat{A}_{44})^{(9)} + \ (\hat{P}_{44})^{(9)}\,(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)} + (b_i^{'})^{(9)} + \ (\hat{B}_{44})^{(9)} + \ (\hat{Q}_{44})^{(9)}\ \ (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13}\right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$:	153

$G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$

Proof: 159

Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$

By 160

$\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}')^{(2)} + a_{16}'')^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{16}(s_{(16)}) \right] ds_{(16)}$

$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}')^{(2)} + (a_{17}'')^{(2)} (T_{17}(s_{(16)}), s_{(17)}) \right) G_{17}(s_{(16)}) \right] ds_{(16)}$

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}')^{(2)} + (a_{18}'')^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{18}(s_{(16)}) \right] ds_{(16)}$

$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}')^{(2)} - (b_{16}'')^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{16}(s_{(16)}) \right] ds_{(16)}$

$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}')^{(2)} - (b_{17}'')^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{17}(s_{(16)}) \right] ds_{(16)}$

$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}')^{(2)} - (b_{18}'')^{(2)} (G_{19}(s_{(16)}), s_{(16)}) \right) T_{18}(s_{(16)}) \right] ds_{(16)}$

Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$

By 161

$\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{20}(s_{(20)}) \right] ds_{(20)}$

$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{21}(s_{(20)}) \right] ds_{(20)}$

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{32})^{(6)}, T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\hat{P}_{36})^{(7)} \,, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\hat{P}_{40})^{(8)} \,, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}')^{(8)} - (b_{40}'')^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}')^{(8)} - (b_{41}'')^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}')^{(8)} - (b_{42}'')^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$, $T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}')^{(9)} + a_{44}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}')^{(9)} - (b_{44}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}')^{(9)} - (b_{45}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}')^{(9)} - (b_{46}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that	168

$(G_{13}(t) - G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)}\left(G_{17}^0 + (\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)}t\right)G_{17}^0 + \frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)}\left(G_{21}^0 + (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)}t\right)G_{21}^0 + \frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t} - 1\right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{P}_{20})^{(3)} + G_{21}^0\right)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)} + (\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)}\left(G_{25}^0 + (\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)}t\right)G_{25}^0 + \frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t} - 1\right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)} + G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)} + (\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176
From which it follows that $(G_{32}(t) - G_{32}^0) e^{-(\hat{M}_{32})^{(6)} t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left[\left((\hat{P}_{32})^{(6)} + G_{33}^0 \right) e^{\left(-\frac{(\hat{P}_{32})^{(6)} + G_{33}^0}{G_{33}^0} \right)} + (\hat{P}_{32})^{(6)} \right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for G_{25} , $G_{26}, T_{24}, T_{25}, T_{26}$	177
(y) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} \left(G_{37}^0 + (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} s_{(36)}} \right) \right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)} t\right) G_{37}^0 + \frac{(a_{36})^{(7)} (\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left(e^{(\hat{M}_{36})^{(7)} t} - 1 \right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0) e^{-(\hat{M}_{36})^{(7)} t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left[\left((\hat{P}_{36})^{(7)} + G_{37}^0 \right) e^{\left(-\frac{(\hat{P}_{36})^{(7)} + G_{37}^0}{G_{37}^0} \right)} + (\hat{P}_{36})^{(7)} \right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}} \right) \right] ds_{(40)} =$	180

$\left(1+(a_{40})^{(8)}t\right)G_{41}^{0}+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	
From which it follows that $(G_{40}(t)-G_{40}^{0})e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^{0}\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^{0}}{G_{41}^{0}}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41} , G_{42}, T_{40}, T_{41}, T_{42}	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t)\leq G_{44}^{0}+\int_0^t\left[(a_{44})^{(9)}\left(G_{45}^{0}+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right]ds_{(44)}=$ $\left(1+(a_{44})^{(9)}t\right)G_{45}^{0}+\frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$	
From which it follows that $(G_{44}(t)-G_{44}^{0})e^{-(\hat{M}_{44})^{(9)}t}\leq\frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^{0}\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^{0}}{G_{45}^{0}}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45} , G_{46}, T_{44}, T_{45}, T_{46}	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
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$sup_i\{\max_{t\in\mathbb{R}_+} \left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{28})^{(5)}t}, \max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{28})^{(5)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{31})}, \widetilde{(T_{31})}$: $\left(\widetilde{(G_{31})}, \widetilde{(T_{31})}\right) = \mathcal{A}^{(5)}\left((G_{31}),(T_{31})\right)$ It results $\left\|\tilde{G}_{28}^{(1)}-\tilde{G}_i^{(2)}\right\| \leq \int_0^t (a_{28})^{(5)}\left\|G_{29}^{(1)}-G_{29}^{(2)}\right\|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}}ds_{(28)} +$ $\int_0^t\{(a'_{28})^{(5)}\left\|G_{28}^{(1)}-G_{28}^{(2)}\right\|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{-(\hat{M}_{28})^{(5)}s_{(28)}} +$ $(a''_{28})^{(5)}\left(T_{29}^{(1)},s_{(28)}\right)\left\|G_{28}^{(1)}-G_{28}^{(2)}\right\|e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}} +$ $G_{28}^{(2)}\left\|(a''_{28})^{(5)}\left(T_{29}^{(1)},s_{(28)}\right)-(a''_{28})^{(5)}\left(T_{29}^{(2)},s_{(28)}\right)\right\| e^{-(\hat{M}_{28})^{(5)}s_{(28)}}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\}ds_{(28)}$ Where $s_{(28)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	
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$G_{28} < (\widehat{M}_{28})^{(5)}$ it follows $\frac{dG_{29}}{dt} \leq \left((\widehat{M}_{28})^{(5)}\right)_1 - (a_{29}^{'})^{(5)} G_{29}$ and by integrating

$G_{29} \leq \left((\widehat{M}_{28})^{(5)}\right)_2 = G_{29}^0 + 2(a_{29})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_1/(a_{29}^{'})^{(5)}$

In the same way , one can obtain

$G_{30} \leq \left((\widehat{M}_{28})^{(5)}\right)_3 = G_{30}^0 + 2(a_{30})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_2/(a_{30}^{'})^{(5)}$

If G_{29} *or* G_{30} is bounded, the same property follows for G_{28} , G_{30} and G_{28} , G_{29} respectively.

Remark 24: If G_{28} *is* bounded, from below, the same property holds for G_{29} *and* G_{30} . The proof is analogous with the preceding one. An analogous property is true if G_{29} is bounded from below. 241

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Definition of $(m)^{(5)}$ and ε_5 :

Indeed let t_5 be so that for $t > t_5$

$(b_{29})^{(5)} - (b_i^{''})^{(5)}((G_{31})(t),t) < \varepsilon_5, T_{28}(t) > (m)^{(5)}$

Then $\frac{dT_{29}}{dt} \geq (a_{29})^{(5)}(m)^{(5)} - \varepsilon_5 T_{29}$ which leads to 243

$T_{29} \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{\varepsilon_5}\right)(1-e^{-\varepsilon_5 t}) + T_{29}^0 e^{-\varepsilon_5 t}$ If we take t such that $e^{-\varepsilon_5 t} = \frac{1}{2}$ it results

$T_{29} \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{2}\right), \quad t = log\frac{2}{\varepsilon_5}$ By taking now ε_5 sufficiently small one sees that T_{29} is unbounded. The same property holds for T_{30} if $\lim_{t\to\infty}(b_{30}^{''})^{(5)}\left((G_{31})(t),t\right) = (b_{30}^{'})^{(5)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations

Analogous inequalities hold also for G_{33} , G_{34}, T_{32}, T_{33}, T_{34}

It is now sufficient to take $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$ and to choose 244

$(\widehat{P}_{32})^{(6)}$ and $(\widehat{Q}_{32})^{(6)}$ large to have

$$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[(\hat{P}_{32})^{(6)} + ((\hat{P}_{32})^{(6)} + G_j^0)e^{-\left(\frac{(\hat{P}_{32})^{(6)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{32})^{(6)}$$ 245

$$\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[((\hat{Q}_{32})^{(6)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{32})^{(6)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{32})^{(6)}\right] \leq (\hat{Q}_{32})^{(6)}$$ 246

In order that the operator $\mathcal{A}^{(6)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself

The operator $\mathcal{A}^{(6)}$ is a contraction with respect to the metric $d\left(\left((G_{35})^{(1)},(T_{35})^{(1)}\right),\left((G_{35})^{(2)},(T_{35})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\widehat{M}_{32})^{(6)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\widehat{M}_{32})^{(6)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{35})},\widetilde{(T_{35})}$: $\left(\widetilde{(G_{35})},\widetilde{(T_{35})}\right)=\mathcal{A}^{(6)}\left((G_{35}),(T_{35})\right)$ It results $\lvert\tilde{G}_{32}^{(1)}-\tilde{G}_i^{(2)}\rvert\leq\int_0^t(a_{32})^{(6)}\lvert G_{33}^{(1)}-G_{33}^{(2)}\rvert e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}ds_{(32)}+$ $\int_0^t\{(a_{32}')^{(6)}\lvert G_{32}^{(1)}-G_{32}^{(2)}\rvert e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}+$ $(a_{32}'')^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)\lvert G_{32}^{(1)}-G_{32}^{(2)}\rvert e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}+$ $G_{32}^{(2)}\lvert(a_{32}'')^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)-(a_{32}'')^{(6)}\left(T_{33}^{(2)},s_{(32)}\right)\rvert\ e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$ Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	247
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The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(\left((G_{39})^{(1)},(T_{39})^{(1)}\right),\left((G_{39})^{(2)},(T_{39})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\widehat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\widehat{M}_{36})^{(7)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{39})},\widetilde{(T_{39})}:\left(\widetilde{(G_{39})},\widetilde{(T_{39})}\right)=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$ It results $\left\|\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}\right\|\leq\int_0^t(a_{36})^{(7)}\left\|G_{37}^{(1)}-G_{37}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\,ds_{(36)}+$ $\int_0^t\{(a'_{36})^{(7)}\left\|G_{36}^{(1)}-G_{36}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}+$ $(a''_{36})^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)\left\|G_{36}^{(1)}-G_{36}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}+$ $G_{36}^{(2)}\|(a''_{36})^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)-(a''_{36})^{(7)}\left(T_{37}^{(2)},s_{(36)}\right)\|\;e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	258
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **Definition of** $\widetilde{(G_{43})},\widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})},\widetilde{(T_{43})}\right)=\mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results $\left\|\tilde{G}_{40}^{(1)}-\tilde{G}_i^{(2)}\right\|\leq\int_0^t(a_{40})^{(8)}\left\|G_{41}^{(1)}-G_{41}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}ds_{(40)}+$ $\int_0^t\{(a'_{40})^{(8)}\left\|G_{40}^{(1)}-G_{40}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{-(\hat{M}_{40})^{(8)}s_{(40)}}+$ $(a''_{40})^{(8)}\left(T_{41}^{(1)},s_{(40)}\right)\left\|G_{40}^{(1)}-G_{40}^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}+$ $G_{40}^{(2)}\|(a''_{40})^{(8)}\left(T_{41}^{(1)},s_{(40)}\right)-(a''_{40})^{(8)}\left(T_{41}^{(2)},s_{(40)}\right)\|\ e^{-(\hat{M}_{40})^{(8)}s_{(40)}}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\}ds_{(40)}$	271
Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
$\left\|(G_{43})^{(1)}-(G_{43})^{(2)}\right\|e^{-(\hat{M}_{40})^{(8)}t}\leq$ $\frac{1}{(\hat{M}_{40})^{(8)}}\left((a_{40})^{(8)}+(a'_{40})^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}\right)d\left(\left((G_{43})^{(1)},(T_{43})^{(1)};\ (G_{43})^{(2)},(T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
Remark 36: The fact that we supposed $(a''_{40})^{(8)}$ and $(b''_{40})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ *and* $(\hat{Q}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(8)}$ and $(b''_i)^{(8)}, i=40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
Remark 37 There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$	275

it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(8)} - (a_i^{''})^{(8)}(T_{41}(s_{(40)}),s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(8)} t)} > 0$ for $t > 0$	
Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}^{'})^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}^{'})^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}^{'})^{(8)}$ If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	276
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Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}^{''})^{(8)}\left((G_{43})(t), t(t), t\right) = (b_{42}^{'})^{(8)}$	279
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have	279 A

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})} : (\widetilde{(G_{47})}, \widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}),(T_{47}))$

It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t\{(a_{44}')^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a_{44}'')^{(9)}(T_{45}^{(1)}, s_{(44)})\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}\left|(a_{44}'')^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a_{44}'')^{(9)}(T_{45}^{(2)}, s_{(44)})\right|\ e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

<u>**Remark 41:**</u> The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ *and* $(\hat{Q}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}$, $i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

<u>**Remark 42:**</u> There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}),s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1/(a_{45}')^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2/(a_{46}')^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}\left((G_{47})(t),t\right)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i'')^{(9)}\left((G_{47})(t),t\right) < \varepsilon_9, T_{44}\,(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}\left((G_{47})(t),t\right) = (b_{46}')^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14}, t) + (a_{14}'')^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}$, $(m_2)^{(1)}$, $(\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}$, $(m_2)^{(1)}$, $(\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}$, $if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}$, $if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a_{15}^{'})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}^{'})^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}^{'})^{(1)}t}\right)$	286

$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\left((G_{19}), t\right) - (b_{17}'')^{(2)}\left((G_{19}), t\right) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)},\boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)},\boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}^{'})^{(2)}$ $(R_2)^{(2)} = (b_{18}^{'})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \le -(a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} - (a_{20}^{''})^{(3)}(T_{21}, t) + (a_{21}^{''})^{(3)}(T_{21}, t) \le -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \le -(b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}, t) - (b_{21}^{''})^{(3)}\big((G_{23}), t\big) \le -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},\ \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},\ \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
<u>Definition of</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
<u>Behavior of the solutions of equation</u> **<u>Theorem:</u>** If we denote and define **<u>Definition of</u>** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}\big((G_{27}), t\big) - (b_{25}'')^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
<u>Definition of</u> $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations	329

$(a_{25})^{(4)}\left(v^{(4)}\right)^2 + (\sigma_1)^{(4)}v^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	
Definition of $(\bar{v}_1)^{(4)},, (\bar{v}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{v}_1)^{(4)} > 0$, $(\bar{v}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(v^{(4)}\right)^2 + (\sigma_2)^{(4)}v^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ ***if*** $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, ***if*** $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ ***if*** $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ ***if*** $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, ***if*** $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}$, ***if*** $(\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}\left((R_1)^{(4)}-(b_{26}')^{(4)}\right)}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}')^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}')^{(4)}$ $(R_2)^{(4)}=(b_{26}')^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\le-(a_{28}')^{(5)}+(a_{29}')^{(5)}-(a_{28}'')^{(5)}(T_{29},t)+(a_{29}'')^{(5)}(T_{29},t)\le-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\le-(b_{28}')^{(5)}+(b_{29}')^{(5)}-(b_{28}'')^{(5)}((G_{31}),t)-(b_{29}'')^{(5)}((G_{31}),t)\le-(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},,(\bar{\nu}_2)^{(5)},(\bar{u}_1)^{(5)},(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)}>0,(\bar{\nu}_2)^{(5)}<0$ and respectively $(\bar{u}_1)^{(5)}>0,(\bar{u}_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar{\nu}_1)^{(5)},\boldsymbol{if}\ (\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},$ ***if*** $(\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}$, ***if*** $(\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},$ ***if*** $(\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},$ ***if*** $(u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}$, ***if*** $(u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)},$ ***if*** $(\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b'_{34})^{(6)})} \left[e^{(R_1)^{(6)}t} - e^{-(b'_{34})^{(6)}t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})} \left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a'_{32})^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b'_{32})^{(6)}$ $(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\left((G_{39}), t\right) - (b''_{37})^{(7)}\left((G_{39}), t\right) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ ,\boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ ,\boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \le G_{36}(t) \le G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
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$(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \le G_{38}(t) \le$ $\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}] + G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \le T_{36}(t) \le T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \le T_{36}(t) \le \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \le T_{38}(t) \le$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
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$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$ $(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$	
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
Definition of $(\bar{\nu}_1)^{(8)}, , (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}$, ***if*** $(\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\ \mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq$ $\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}] + G_{42}^0 e^{-(a_{42}')^{(8)}t})$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>Definition of</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if}\ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if}\ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if}\ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if}\ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if}\ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

(

$$\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0e^{-(S_2)^{(9)}t}\leq G_{46}(t)\leq$$

$$\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}\left[e^{(S_1)^{(9)}t}-e^{-(a_{46}')^{(9)}t}\right]+G_{46}^0e^{-(a_{46}')^{(9)}t})$$

$$\boxed{T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}}T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq\frac{1}{(\mu_2)^{(9)}}T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b_{46}')^{(9)}t}\right]+T_{46}^0e^{-(b_{46}')^{(9)}t}\leq T_{46}(t)\leq$$

$$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)},(S_2)^{(9)},(R_1)^{(9)},(R_2)^{(9)}$:-

Where $(S_1)^{(9)}=(a_{44})^{(9)}(m_2)^{(9)}-(a_{44}')^{(9)}$

$(S_2)^{(9)}=(a_{46})^{(9)}-(p_{46})^{(9)}$

$(R_1)^{(9)}=(b_{44})^{(9)}(\mu_2)^{(9)}-(b_{44}')^{(9)}$

$(R_2)^{(9)}=(b_{46}')^{(9)}-(r_{46})^{(9)}$

Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have	386

Definition of $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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In the same manner , we get	391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
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If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
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$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \le \frac{d\nu^{(3)}}{dt} \le -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \ge \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \le \nu^{(3)}(t) \le (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \le \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \le \nu^{(3)}(t) \le (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \le \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \le \nu^{(3)}(t) \le$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \le (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \le (\bar{\nu}_1)^{(3)} \le (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \le \nu^{(3)}(t) \le \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \le (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:-	403

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains **Definition of** $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:- For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$ $\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}$, $\boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$ it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$	
In the same manner , we get $\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{5 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}$, $\boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\bar{\nu}_2)^{(5)}}}$ From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$	409
If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, $(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}}{1 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$	410
If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain $(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(5)}(t)$:- $(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}$, $\boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(5)}(t)$:- $(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$	411

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ **<u>Definition of</u>** $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains **<u>Definition of</u>** $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:-	424

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

Proof : From 99,20,44,22,23,44 we obtain 424 A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}'')^{(9)} = (a_{45}'')^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}'')^{(9)} = (b_{45}'')^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i'')^{(1)} and\ (b_i'')^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}')^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}')^{(1)}(r_{14})^{(1)} - (b_{14}')^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

$with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
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Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
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Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457

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$(b_{24})^{(4)}T_{25} - [(b'_{24})^{(4)} - (b''_{24})^{(4)}((G_{27}))]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b'_{25})^{(4)} - (b''_{25})^{(4)}((G_{27}))]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b'_{26})^{(4)} - (b''_{26})^{(4)}((G_{27}))]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) +$ $(a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (y) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) +$	486

$(a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
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Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
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Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right] + (b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right] + (b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right] + (b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27}) + (b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right] + (b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31}) + (b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right] + (b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35}) + (b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right] + (b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39}) + (b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right] + (b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi({G_{43}}^*) = 0$	
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{45} such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G^*_{14} given by $\varphi(G^*) = 0$, T^*_{14} given by $f(T^*_{14}) = 0$ and $G^*_{13} = \frac{(a_{13})^{(1)}G^*_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G^*_{15} = \frac{(a_{15})^{(1)}G^*_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$ $T^*_{13} = \frac{(b_{13})^{(1)}T^*_{14}}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T^*_{15} = \frac{(b_{15})^{(1)}T^*_{14}}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G^*_{17} given by $\varphi((G_{19})^*) = 0$, T^*_{17} given by $f(T^*_{17}) = 0$ and	512
$G^*_{16} = \frac{(a_{16})^{(2)}G^*_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G^*_{18} = \frac{(a_{18})^{(2)}G^*_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	513
$T^*_{16} = \frac{(b_{16})^{(2)}T^*_{17}}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T^*_{18} = \frac{(b_{18})^{(2)}T^*_{17}}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G^*_{21} given by $\varphi((G_{23})^*) = 0$, T^*_{21} given by $f(T^*_{21}) = 0$ and $G^*_{20} = \frac{(a_{20})^{(3)}G^*_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G^*_{22} = \frac{(a_{22})^{(3)}G^*_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$ $T^*_{20} = \frac{(b_{20})^{(3)}T^*_{21}}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}({G_{23}}^*)]}$, $T^*_{22} = \frac{(b_{22})^{(3)}T^*_{21}}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}({G_{23}}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^* = \frac{(a_{24})^{(4)}G_{25}^*}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)}G_{25}^*}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)}T_{25}^*}{[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)}T_{25}^*}{[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*)=0$, T_{29}^* given by $f(T_{29}^*)=0$ and $G_{28}^* = \frac{(a_{28})^{(5)}G_{29}^*}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)}G_{29}^*}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)}T_{29}^*}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)}T_{29}^*}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*)=0$, T_{33}^* given by $f(T_{33}^*)=0$ and $G_{32}^* = \frac{(a_{32})^{(6)}G_{33}^*}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)}G_{33}^*}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)}T_{33}^*}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)}T_{33}^*}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*)=0$, T_{37}^* given by $f(T_{37}^*)=0$ and $G_{36}^* = \frac{(a_{36})^{(7)}G_{37}^*}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)}G_{37}^*}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)}T_{37}^*}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)}T_{37}^*}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*)=0$, T_{41}^* given by $f(T_{41}^*)=0$ and $G_{40}^* = \frac{(a_{40})^{(8)}G_{41}^*}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)}G_{41}^*}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^*)]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$ 532

$$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$$ 533

taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$$ 534

$$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$$ 535

$$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$$ 536

$$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$$ 537

$$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$$ 538

$$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$$ 539

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Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$$

Then taking into account equations and neglecting the terms of power 2, we obtain

$$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$$ 541

$$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$$ 542

$$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$$ 543

$$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$$ 544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}(\,(G_{31})^{*}\,) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt}=-\left((a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\mathbb{G}_{28}+(a_{28})^{(5)}\mathbb{G}_{29}-(q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt}=-\left((a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)\mathbb{G}_{29}+(a_{29})^{(5)}\mathbb{G}_{28}-(q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt}=-\left((a_{30}^{'})^{(5)}+(p_{30})^{(5)}\right)\mathbb{G}_{30}+(a_{30})^{(5)}\mathbb{G}_{29}-(q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt}=-\left((b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)\mathbb{T}_{28}+(b_{28})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_{j}\right)$	560
$\frac{d\mathbb{T}_{29}}{dt}=-\left((b_{29}^{'})^{(5)}-(r_{29})^{(5)}\right)\mathbb{T}_{29}+(b_{29})^{(5)}\mathbb{T}_{28}+\sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_{j}\right)$	561
$\frac{d\mathbb{T}_{30}}{dt}=-\left((b_{30}^{'})^{(5)}-(r_{30})^{(5)}\right)\mathbb{T}_{30}+(b_{30})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_{j}\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad , T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*})=(q_{33})^{(6)} \quad , \frac{\partial(b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^{*}\,)=s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt}=-\left((a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\mathbb{G}_{32}+(a_{32})^{(6)}\mathbb{G}_{33}-(q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt}=-\left((a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)\mathbb{G}_{33}+(a_{33})^{(6)}\mathbb{G}_{32}-(q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt}=-\left((a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)\mathbb{G}_{34}+(a_{34})^{(6)}\mathbb{G}_{33}-(q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt}=-\left((b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)\mathbb{T}_{32}+(b_{32})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_{j}\right)$	568
$\frac{d\mathbb{T}_{33}}{dt}=-\left((b_{33}^{'})^{(6)}-(r_{33})^{(6)}\right)\mathbb{T}_{33}+(b_{33})^{(6)}\mathbb{T}_{32}+\sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_{j}\right)$	569
$\frac{d\mathbb{T}_{34}}{dt}=-\left((b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\mathbb{T}_{34}+(b_{34})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_{j}\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \;,\; \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \;,\; \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \ , \ \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}(\,(G_{47})^*\,) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*} + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b'_{13})^{(1)} + (b'_{14})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a'_{13})^{(1)} + (a'_{14})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)})\left((a_{15})^{(1)}(q_{14})^{(1)}G^*_{14} + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G^*_{13}\right)$$

$$\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T^*_{14} + (b_{14})^{(1)}s_{(13),(15)}T^*_{13}\right)\} = 0$$

$$+$$

$$((\lambda)^{(2)} + (b'_{18})^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a'_{18})^{(2)} + (p_{18})^{(2)})$$

$$\left[\left(\left((\lambda)^{(2)} + (a'_{16})^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}^*_{17} + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}^*_{16}\right)\right]$$

$$\left(\left((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}^*_{17}\right)$$

$$+\left(\left((\lambda)^{(2)} + (a'_{17})^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}^*_{16} + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}^*_{17}\right)$$

$$\left(\left((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}^*_{16}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a'_{16})^{(2)} + (a'_{17})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b'_{16})^{(2)} + (b'_{17})^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a'_{16})^{(2)} + (a'_{17})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+((\lambda)^{(2)} + (a'_{16})^{(2)} + (p_{16})^{(2)})\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}^*_{17} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}^*_{16}\right)$$

$$\left(\left((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}^*_{16}\right)\} = 0$$

$$+$$

$$((\lambda)^{(3)} + (b'_{22})^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a'_{22})^{(3)} + (p_{22})^{(3)})$$

$$\left[\left(\left((\lambda)^{(3)} + (a'_{20})^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G^*_{21} + (a_{21})^{(3)}(q_{20})^{(3)}G^*_{20}\right)\right]$$

$$\left(\left((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T^*_{21} + (b_{21})^{(3)}s_{(20),(21)}T^*_{21}\right)$$

$$+\left(\left((\lambda)^{(3)} + (a'_{21})^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G^*_{20} + (a_{20})^{(3)}(q_{21})^{(1)}G^*_{21}\right)$$

$$\left(\left((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T^*_{21} + (b_{21})^{(3)}s_{(20),(20)}T^*_{20}\right)$$

$\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2 + \left((b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\} = 0$ +	
$((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)})$ $\left[\left(\left((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)})$ $\left[\left(\left((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(\left((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}')^{(5)} + (a_{29}')^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$ $\left(\left((\lambda)^{(5)}\right)^2 + \left((b_{28}')^{(5)} + (b_{29}')^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$ $+\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}')^{(5)} + (a_{29}')^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right) (q_{30})^{(5)} G_{30}$ $+((\lambda)^{(5)} + (a_{28}')^{(5)} + (p_{28})^{(5)}) \left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^* + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^*\right)$ $\left(\left((\lambda)^{(5)} + (b_{28}')^{(5)} - (r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^* + (b_{29})^{(5)}s_{(28),(30)}T_{28}^*\right)\} = 0$ $+$	
$((\lambda)^{(6)} + (b_{34}')^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a_{34}')^{(6)} + (p_{34})^{(6)})$ $\left[\left(\left((\lambda)^{(6)} + (a_{32}')^{(6)} + (p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^* + (a_{33})^{(6)}(q_{32})^{(6)}G_{32}^*\right)\right]$ $\left(\left((\lambda)^{(6)} + (b_{32}')^{(6)} - (r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^* + (b_{33})^{(6)}s_{(32),(33)}T_{33}^*\right)$ $+\left(\left((\lambda)^{(6)} + (a_{33}')^{(6)} + (p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^* + (a_{32})^{(6)}(q_{33})^{(6)}G_{33}^*\right)$ $\left(\left((\lambda)^{(6)} + (b_{32}')^{(6)} - (r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^* + (b_{33})^{(6)}s_{(32),(32)}T_{32}^*\right)$ $\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}')^{(6)} + (a_{33}')^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$ $\left(\left((\lambda)^{(6)}\right)^2 + \left((b_{32}')^{(6)} + (b_{33}')^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$ $+\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}')^{(6)} + (a_{33}')^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right) (q_{34})^{(6)} G_{34}$ $+((\lambda)^{(6)} + (a_{32}')^{(6)} + (p_{32})^{(6)}) \left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^* + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^*\right)$ $\left(\left((\lambda)^{(6)} + (b_{32}')^{(6)} - (r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^* + (b_{33})^{(6)}s_{(32),(34)}T_{32}^*\right)\} = 0$ $+$ $((\lambda)^{(7)} + (b_{38}')^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a_{38}')^{(7)} + (p_{38})^{(7)})$ $\left[\left(\left((\lambda)^{(7)} + (a_{36}')^{(7)} + (p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^* + (a_{37})^{(7)}(q_{36})^{(7)}G_{36}^*\right)\right]$ $\left(\left((\lambda)^{(7)} + (b_{36}')^{(7)} - (r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^* + (b_{37})^{(7)}s_{(36),(37)}T_{37}^*\right)$ $+\left(\left((\lambda)^{(7)} + (a_{37}')^{(7)} + (p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^* + (a_{36})^{(7)}(q_{37})^{(7)}G_{37}^*\right)$ $\left(\left((\lambda)^{(7)} + (b_{36}')^{(7)} - (r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^* + (b_{37})^{(7)}s_{(36),(36)}T_{36}^*\right)$	

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)})\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)})s_{(37),(38)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2 + \left((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2 + \left((b_{44}^{'})^{(9)} + (b_{45}^{'})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^2 + \left((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\} = 0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION TWENTY SIX

Lightcone Fluctuations And Stress Tensor Fluctuations

INTRODUCTION—VARIABLES USED

A Model for Lightcone Fluctuations due to Stress Tensor Fluctuations C.H.G. Bessa, V.A. De Lorenci, L.H. Ford, C.C.H. Ribeiro

- **(1)** Authors also discuss the dependence of the squared electric field fluctuations upon (e&eb) the geometry of the material, which in turn determines (eb) a sampling function for (e) averaging the squared electric field along the path of the pulse.
- **(2)** This allows (eb) us to estimate the probability of especially large fluctuations, which is (=) a measure of the probability distribution for quantum stress tensor fluctuations. Subjects: General Relativity and Quantum Cosmology (gr-qc); High Energy Physics - Theory (hep-th); Quantum Physics (quant-ph) Cite as: arXiv:1602.03857 [gr-qc] (or arXiv:1602.03857v1 [gr-qc] for this version)

NOTATION

Module One

When this material has a non-zero third order polarizability the flight time variations arise from squared electric field fluctuations, and are (=) analogous to effects expected when (e) the stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations

G_{13} : Category one of material has a non-zero third order polarizability the flight time variations arise from squared electric field fluctuations

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of effects expected when (e) the stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

When this material has a non-zero third order polarizability the flight time variations arise from squared electric field fluctuations, and are analogous to effects expected when (e) the stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations

G_{16} : Category one of **material has a non-zero third order polarizability the flight time variations arise from squared electric field fluctuations, and are analogous to effects expected;** stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of stress tensor of a quantized field drives (eb) passive spacetime geometry fluctuations; **material has a non-zero third order polarizability the flight time variations arise from squared electric field fluctuations, and are analogous to effects expected**

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

When this material has a non-zero third order polarizability the flight time variations arise from squared electric field fluctuations, and are analogous to effects expected when the stress tensor of a quantized field drives (eb) **passive spacetime geometry fluctuations**

G_{20} : Category one of material has a non-zero third order polarizability the flight time variations arise from squared electric field fluctuations, and are analogous to effects expected when the stress tensor of a quantized field

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of **passive spacetime geometry fluctuations**

T_{21} : Category two of SAS

T_{22} : Category three of SAS

Module four

Authors also discuss the dependence of the squared electric field fluctuations upon (e&eb) the geometry of the material, which in turn determines (eb) a sampling function for (e) averaging the squared electric field along the path of the pulse

G_{24} : Category one of **dependence of the squared electric field fluctuations;** geometry of the material, which in turn determines (eb) a sampling function for (e) averaging the squared electric field along the path of the pulse

G_{25} : Category two of SAS

G_{26} : Category three of SAS

T_{24} : Category one of geometry of the material, which in turn determines (eb) a sampling function for (e) averaging the squared electric field along the path of the pulse **;dependence of the squared electric field fluctuations**

T_{25} : Category two of SAS

T_{26} : Category three of SAS

Module five

Authors also discuss the dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines (eb) a sampling function for (e) averaging the squared electric field along the path of the pulse

G_{28} : Category one of dependence of the squared electric field fluctuations upon the geometry of the material

G_{29} : Category two of SAS

G_{30} : Category three of SAS

T_{28} : Category one of sampling function for (e) averaging the squared electric field along the path of the pulse

T_{29} : Category two of SAS

T_{30} : Category three of SAS

Module six

Authors also discuss the dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines a sampling function for averaging the squared electric field along the path of the pulse

G_{32} : Category one of **dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines a sampling function;** averaging the squared electric field along the path of the pulse

G_{33} : Category two of SAS

G_{34} : Category three of SAS

T_{32} : Category one of averaging the squared electric field along the path of the pulse **;dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines a sampling function**

T_{33} : Category two of SAS

T_{34} : Category three of SAS

Module seven

dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines a sampling function for averaging the squared electric field along the path of the pulse allows (eb) us to estimate the probability of especially large fluctuations, which is (=) a measure of the probability distribution for quantum stress tensor fluctuations.

Subjects: General Relativity and Quantum Cosmology (gr-qc); High Energy Physics - Theory (hep-th); Quantum Physics (quant-ph) Cite as: arXiv:1602.03857 [gr-qc] (or arXiv:1602.03857v1 [gr-qc] for this version)

G_{36} : Category one of dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines a sampling function for averaging the squared electric field along the path of the pulse

G_{37} : Category two of SAS

G_{38} : Category three of SAS

T_{36} : Category one of estimate the probability of especially large fluctuations, which is (=) a measure of the probability distribution for quantum stress tensor fluctuations.

T_{37} : Category two of SAS

T_{38} : Category three of SAS

Module eight

dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines a sampling function for averaging the squared electric field along the path of the pulse allows us to estimate the probability of especially large fluctuations, which is (=) a measure of the probability distribution for quantum stress tensor fluctuations.

G_{40} : Category one of dependence of the squared electric field fluctuations upon the geometry of the material, which in turn determines a sampling function for averaging the squared electric field along the path of the pulse allows us to estimate the probability of especially large fluctuations

G_{41} : Category two of SAS

G_{42} : Category three of SAS

T_{40} : Category one of distribution for quantum stress tensor fluctuations

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

distribution for quantum stress tensor fluctuations

G_{44} : Category one of distribution quantum stress tensor fluctuations

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one o quantum stress tensor fluctuations ; f distribution

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:	
$(a_{13})^{(1)},(a_{14})^{(1)},(a_{15})^{(1)},(b_{13})^{(1)},(b_{14})^{(1)},(b_{15})^{(1)}$ $(a_{16})^{(2)},(a_{17})^{(2)},(a_{18})^{(2)}$ $(b_{16})^{(2)},(b_{17})^{(2)},(b_{18})^{(2)}$: $(a_{20})^{(3)},(a_{21})^{(3)},(a_{22})^{(3)}$, $(b_{20})^{(3)},(b_{21})^{(3)},(b_{22})^{(3)}$ $(a_{24})^{(4)},(a_{25})^{(4)},(a_{26})^{(4)},(b_{24})^{(4)},(b_{25})^{(4)},(b_{26})^{(4)},(b_{28})^{(5)},(b_{29})^{(5)},(b_{30})^{(5)},(a_{28})^{(5)},(a_{29})^{(5)},(a_{30})^{(5)}$, $(a_{32})^{(6)},(a_{33})^{(6)},(a_{34})^{(6)},(b_{32})^{(6)},(b_{33})^{(6)},(b_{34})^{(6)}$ $(a_{36})^{(7)},(a_{37})^{(7)},(a_{38})^{(7)},(b_{36})^{(7)},(b_{37})^{(7)},(b_{38})^{(7)}$ $(a_{40})^{(8)},(a_{41})^{(8)},(a_{42})^{(8)},(b_{40})^{(8)},(b_{41})^{(8)},(b_{42})^{(8)}$ $(a_{44})^{(9)},(a_{45})^{(9)},(a_{46})^{(9)},(b_{44})^{(9)},(b_{45})^{(9)},(b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)},(a'_{14})^{(1)},(a'_{15})^{(1)},(b'_{13})^{(1)},(b'_{14})^{(1)},(b'_{15})^{(1)},(a'_{16})^{(2)},(a'_{17})^{(2)},(a'_{18})^{(2)}$, $(b'_{16})^{(2)},(b'_{17})^{(2)},(b'_{18})^{(2)}$, $(a'_{20})^{(3)},(a'_{21})^{(3)},(a'_{22})^{(3)},(b'_{20})^{(3)},(b'_{21})^{(3)},(b'_{22})^{(3)}$ $(a'_{24})^{(4)},(a'_{25})^{(4)},(a'_{26})^{(4)},(b'_{24})^{(4)},(b'_{25})^{(4)},(b'_{26})^{(4)},(b'_{28})^{(5)},(b'_{29})^{(5)},(b'_{30})^{(5)}$ $(a'_{28})^{(5)},(a'_{29})^{(5)},(a'_{30})^{(5)}$, $(a'_{32})^{(6)},(a'_{33})^{(6)},(a'_{34})^{(6)},(b'_{32})^{(6)},(b'_{33})^{(6)},(b'_{34})^{(6)}$ $(a'_{36})^{(7)},(a'_{37})^{(7)},(a'_{38})^{(7)},(b'_{36})^{(7)},(b'_{37})^{(7)},(b'_{38})^{(7)}$, $(a'_{40})^{(8)},(a'_{41})^{(8)},(a'_{42})^{(8)},(b'_{40})^{(8)},(b'_{41})^{(8)},(b'_{42})^{(8)}$, $(a'_{44})^{(9)},(a'_{45})^{(9)},(a'_{46})^{(9)},(b'_{44})^{(9)},(b'_{45})^{(9)},(b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt}=(a_{13})^{(1)}G_{14}-\left[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt}=(a_{14})^{(1)}G_{13}-\left[(a'_{14})^{(1)}+(a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\left[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3

$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\big((G_{19}),t\big) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\big((G_{27}),t\big)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\big((G_{27}),t\big)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\big((G_{27}),t\big)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	

$-(b''_{24})^{(4)}((G_{27}),t) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}((G_{31}),t)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}((G_{31}),t)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}((G_{31}),t)\right]T_{30}$	30
$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}((G_{31}),t) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}((G_{35}),t)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}((G_{35}),t)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}((G_{35}),t)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}((G_{39}),t)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}((G_{39}),t)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}((G_{39}),t)\right]T_{38}$	*42*
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	*44*

$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}), t\right) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}), t\right) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}), t\right) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}), t\right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}), t\right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}), t\right) \right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}), t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for	

1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b'_{13})^{(1)}\boxed{-(b''_{13})^{(1)}(G,t)} \; \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \; \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \; \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \; \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \; \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \; \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13} \quad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b'_{14})^{(1)}\boxed{-(b''_{14})^{(1)}(G,t)} \; \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \; \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \; \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \; \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \; \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \; \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14} \quad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b'_{15})^{(1)}\boxed{-(b''_{15})^{(1)}(G,t)} \; \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \; \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \; \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \; \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \; \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \; \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15} \quad 60$$

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)}\boxed{+(a''_{16})^{(2)}(T_{17},t)} \; \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \; \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \; \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \; \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \; \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \; \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16} \quad 61$$

$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category	

1,2 and 3 $-(b''_{20})^{(3,3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,)}(G_{23},t)$ are third detrition coefficients for category 1,2 and 3 $-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1,2 and 3 $-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1,2 and 3 $-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1,2 and 3 $-(b''_{36})^{(7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3 $-(b''_{40})^{(8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3 $-(b''_{44})^{(9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} +(a''_{20})^{(3)}(T_{21},t) +(a''_{16})^{(2,2,2)}(T_{17},t) +(a''_{13})^{(1,1,1,)}(T_{14},t) \\ +(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t) +(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t) +(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{36})^{(7,7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8,8)}(T_{41},t) +(a''_{44})^{(9,9,9)}(T_{45},t) \end{matrix} \right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} +(a''_{21})^{(3)}(T_{21},t) +(a''_{17})^{(2,2,2)}(T_{17},t) +(a''_{14})^{(1,1,1,)}(T_{14},t) \\ +(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t) +(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t) +(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{37})^{(7,7,7,7)}(T_{37},t) +(a''_{41})^{(8,8,8,8)}(T_{41},t) +(a''_{45})^{(9,9,9)}(T_{45},t) \end{matrix} \right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} +(a''_{22})^{(3)}(T_{21},t) +(a''_{18})^{(2,2,2)}(T_{17},t) +(a''_{15})^{(1,1,1,)}(T_{14},t) \\ +(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t) +(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t) +(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{38})^{(7,7,7,7)}(T_{37},t) +(a''_{42})^{(8,8,8,8)}(T_{41},t) +(a''_{46})^{(9,9,9)}(T_{45},t) \end{matrix} \right] G_{22}$	69
$+(a''_{20})^{(3)}(T_{21},t)$, $+(a''_{21})^{(3)}(T_{21},t)$, $+(a''_{22})^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation	

coefficients for category 1, 2 and 3

$\boxed{+(a_{40}'')^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{44}'')^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b_{20}')^{(3)} \boxed{-(b_{20}'')^{(3)}(G_{23},t)} \boxed{-(b_{16}'')^{(2,2,2)}(G_{19},t)} \boxed{-(b_{13}'')^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b_{21}')^{(3)} \boxed{-(b_{21}'')^{(3)}(G_{23},t)} \boxed{-(b_{17}'')^{(2,2,2)}(G_{19},t)} \boxed{-(b_{14}'')^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b_{22}')^{(3)} \boxed{-(b_{22}'')^{(3)}(G_{23},t)} \boxed{-(b_{18}'')^{(2,2,2)}(G_{19},t)} \boxed{-(b_{15}'')^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9)}(G_{47},t)} \end{matrix}\right] T_{22} \quad 72$$

$\boxed{-(b_{20}'')^{(3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{16}'')^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{13}'')^{(1,1,1,)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{36}'')^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b_{38}'')^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{40}'')^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{46}'')^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[\begin{matrix} (a_{24}')^{(4)} \boxed{+(a_{24}'')^{(4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25}$$ 74

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$$ 75

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24}$$ 76

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25}$$ 77

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$$ 78

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients*

$for\ category$ 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category$ 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ $are\ fourth\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ $are\ fifth\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ $are\ sixth\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ $are\ seventh\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ $are\ eighth\ detrition\ coefficients\ for\ category$ 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
$Where$ $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ $are\ first\ augmentation\ coefficients\ for\ category$ 1, 2 and 3 And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ $are\ second\ augmentation\ coefficient\ for\ category$ 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category$ 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation	

coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[\begin{matrix}(b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\ \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{28}$	82
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[\begin{matrix}(b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\ \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{29}$	83
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[\begin{matrix}(b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\ \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\ \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{30}$	84
$where\ \boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}$ $-\left[\begin{matrix}(a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\ \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\ \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\ \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\ \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\ \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\ \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{32}$	85

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34} \quad 87$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$

seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$

Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34} \quad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 91

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$ 92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$ 93

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$	

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{array}{ccc} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{array}{ccc} (b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{array}{ccc} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{array}{ccc} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{array}\right] G_{13}$$ 96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{array}{ccc} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} & \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{array}\right] G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{array}{ccc} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} & \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{array}\right] G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$\frac{dT_{44}}{dt} =$

$(b_{44})^{(9)}T_{45} -$

$$\begin{bmatrix} (b_{44}^{'})^{(9)} \boxed{-(b_{44}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$$(b_{45})^{(9)} T_{44} - \begin{bmatrix} (b_{45}^{'})^{(9)} \boxed{-(b_{45}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$$(b_{46})^{(9)} T_{45} - \begin{bmatrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3

Where we suppose

$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i,j = 13,14,15$ 97

The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(1)}, \ (r_i)^{(1)}$:

$(a_i^{''})^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i^{''})^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b_i^{'})^{(1)} \leq (\hat{B}_{13})^{(1)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i^{''})^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(1)}(T_{14}^{'},t) - (a_i^{''})^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}^{'}\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i^{''})^{(1)}(G^{'},t) - (b_i^{''})^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G^{'}\rvert\lvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(1)}(T_{14}^{'},t)$ and $(a_i^{''})^{(1)}(T_{14},t)$. $(T_{14}^{'},t)$ and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i^{''})^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i^{''})^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i^{'})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i^{'})^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i^{'})^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i^{'})^{(2)}, (a_i^{''})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (b_i^{''})^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i^{''})^{(2)}, (b_i^{''})^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	

$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty} (a_i'')^{(2)} (T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty} (b_i'')^{(2)} \left((G_{19}),t\right) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}\left((G_{19}),t\right)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19}) - (G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i')^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)} (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$	112

The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, (r_i)^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(3)}(T_{21}, t) = (p_i)^{(3)}$ $\lim_{G\to\infty}(b_i^{''})^{(3)}(G_{23}, t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(3)}(T_{21}^{'}, t) - (a_i^{''})^{(3)}(T_{21}, t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}^{'}\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i^{''})^{(3)}(G_{23}{}', t) - (b_i^{''})^{(3)}(G_{23}, t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}{}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and $(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i, j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded.	117

Definition of $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}),t) \leq\ (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i^{''})^{(4)}((G_{27}),t) =\ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25} - T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27}) - (G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and$(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120
Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\,(a_i)^{(4)} + (a_i^{'})^{(4)} +\ (\hat{A}_{24})^{(4)} +\ (\hat{P}_{24})^{(4)}\,(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\,(b_i)^{(4)} + (b_i^{'})^{(4)} +\ (\hat{B}_{24})^{(4)} +\ (\hat{Q}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded.	122

Definition of $(p_i)^{(5)}, \ (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}),t) \leq \ (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$	
$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t) = \ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(5)}(T_{29}^{'},t) - (a_i^{''})^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}^{'}\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i^{''})^{(5)}((G_{31})^{'},t) - (b_i^{''})^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})^{'}\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and$(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}} \ , \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and \ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i^{'})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)} + (a_i^{'})^{(5)} + \ (\hat{A}_{28})^{(5)} + \ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)} + (b_i^{'})^{(5)} + \ (\hat{B}_{28})^{(5)} + \ (\hat{Q}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i^{'})^{(6)}, (a_i^{''})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (b_i^{''})^{(6)} > 0, \quad i,j = 32,33,34$	127

The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, \ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t) \leq \ (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	
$lim_{T_2\to\infty}(a_i'')^{(6)}(T_{33},t) = (p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}\big((G_{35}),t\big) = \ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	128
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}',t) - (a_i'')^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)}\lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i'')^{(6)}((G_{35})',t) - (b_i'')^{(6)}\big((G_{35}),t\big)\rvert < (\hat{k}_{32})^{(6)}\lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}',t)$ and$(a_i'')^{(6)}(T_{33},t)$. (T_{33}',t) and (T_{33},t) are points belonging to the interval $\big[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\big]$. It is to be noted that $(a_i'')^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i')^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)}\ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i')^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)}\ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	

(UUUUUU) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ 131

(VVVVVV) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(7)}, \ (r_i)^{(7)}$:

$$(a_i^{''})^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$$

$$(b_i^{''})^{(7)}(G_{39}, t) \leq (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$$

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(WWWWWW) $\lim_{T_2 \to \infty} (a_i^{''})^{(7)}(T_{37}, t) = (p_i)^{(7)}$

(XXXXXX)

$$\lim_{G \to \infty} (b_i^{''})^{(7)}\left((G_{39}), t\right) = (r_i)^{(7)}$$

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$:

Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$

They satisfy Lipschitz condition: 133

$$|(a_i^{''})^{(7)}(T_{37}^{'}, t) - (a_i^{''})^{(7)}(T_{37}, t)| \leq (\hat{k}_{36})^{(7)}|T_{37} - T_{37}^{'}|e^{-(\hat{M}_{36})^{(7)}t}$$

$$|(b_i^{''})^{(7)}((G_{39})^{'}, t) - (b_i^{''})^{(7)}\left((G_{39}), t\right)| < (\hat{k}_{36})^{(7)}||(G_{39}) - (G_{39})^{'}||e^{-(\hat{M}_{36})^{(7)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'}, t)$ and$(a_i^{''})^{(7)}(T_{37}, t)$. $(T_{37}^{'}, t)$ and (T_{37}, t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i^{''})^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i^{''})^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: 134

(YYYYYY) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants

$$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$$

Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: 135

(ZZZZZZ) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and \ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities

$$\frac{1}{(\hat{M}_{36})^{(7)}}[\ (a_i)^{(7)} + (a_i^{'})^{(7)} + \ (\hat{A}_{36})^{(7)} + \ (\hat{P}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}] < 1$$

$\frac{1}{(\hat{M}_{36})^{(7)}}[\ (b_i)^{(7)}+(b_i^{'})^{(7)}+\ (\hat{B}_{36})^{(7)}+(\hat{Q}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}]<1$	
Where we suppose	
$(a_i)^{(8)},(a_i^{'})^{(8)},(a_i^{''})^{(8)},(b_i)^{(8)},(b_i^{'})^{(8)},(b_i^{''})^{(8)}>0,\quad i,j=40,41,42$	136
The functions $(a_i^{''})^{(8)},(b_i^{''})^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)},\ (r_i)^{(8)}$:	137
$(a_i^{''})^{(8)}(T_{41},t)\le(p_i)^{(8)}\le(\hat{A}_{40})^{(8)}$	138
$(b_i^{''})^{(8)}((G_{43}),t)\le\ (r_i)^{(8)}\le(b_i^{'})^{(8)}\le(\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i^{''})^{(8)}(T_{41},t)=(p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i^{''})^{(8)}\big((G_{43}),t\big)=\ (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)},(\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)},(\hat{B}_{40})^{(8)},(p_i)^{(8)},\ (r_i)^{(8)}}$ are positive constants and $\boxed{i=40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'},t)-(a_i^{''})^{(8)}(T_{41},t)\rvert\le(\hat{k}_{40})^{(8)}\lvert T_{41}-T_{41}^{'}\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i^{''})^{(8)}((G_{43})^{'},t)-(b_i^{''})^{(8)}\big((G_{43}),t\big)\rvert<(\hat{k}_{40})^{(8)}\lvert\lvert(G_{43})-(G_{43})^{'}\rvert\lvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}^{'},t)$ and $(a_i^{''})^{(8)}(T_{41},t)$. $(T_{41}^{'},t)$ and (T_{41},t) are points belonging to the interval $\big[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}\big]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)}=1$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},$ are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\ ,\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}<1$	144
Definition of $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i^{'})^{(8)},(b_i)^{(8)},(b_i^{'})^{(8)},(p_i)^{(8)},\ (r_i)^{(8)},i=40,41,42,$	

Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i')^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)} (\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i')^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)} (\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i'')^{(9)}, (b_i'')^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45}, t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47}, t) \leq (r_i)^{(9)} \leq (b_i')^{(9)} \leq (\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2 \to \infty} (a_i'')^{(9)}(T_{45}, t) = (p_i)^{(9)}$ $\lim_{G \to \infty} (b_i'')^{(9)}(G_{47}, t) = (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$: Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$	
They satisfy Lipschitz condition: $\lvert (a_i'')^{(9)}(T_{45}', t) - (a_i'')^{(9)}(T_{45}, t) \rvert \leq (\hat{k}_{44})^{(9)} \lvert T_{45} - T_{45}' \rvert e^{-(\hat{M}_{44})^{(9)} t}$ $\lvert (b_i'')^{(9)}((G_{47})', t) - (b_i'')^{(9)}((G_{47}), t) \rvert < (\hat{k}_{44})^{(9)} \lVert (G_{47}) - (G_{47})' \rVert e^{-(\hat{M}_{44})^{(9)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}', t)$ and $(a_i'')^{(9)}(T_{45}, t)$. (T_{45}', t) and (T_{45}, t) are points belonging to the interval $[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i'')^{(9)}(T_{45}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with	

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i^{'})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i^{'})^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}, \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}, \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0), T_i(0)$

$$G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}, \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}, \quad T_i(0) = T_i^0 > 0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}, \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}, \quad T_i(0) = T_i^0 > 0$$

Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 150

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}, \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}, \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 151

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}, \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}, \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 152

Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	

$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a'_{20})^{(3)} + a''_{20})^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{20}(s_{(20)}) \right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a'_{21})^{(3)} + (a''_{21})^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a'_{22})^{(3)} + (a''_{22})^{(3)} (T_{21}(s_{(20)}), s_{(20)}) \right) G_{22}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b'_{20})^{(3)} - (b''_{20})^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{20}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b'_{21})^{(3)} - (b''_{21})^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{21}(s_{(20)}) \right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b'_{22})^{(3)} - (b''_{22})^{(3)} (G_{23}(s_{(20)}), s_{(20)}) \right) T_{22}(s_{(20)}) \right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{24})^{(4)}, T_i^0 \le (\hat{Q}_{24})^{(4)}$,	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to$	

$\mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{28} \,)^{(5)} \, , T_i^0 \leq (\, \hat{Q}_{28} \,)^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{28} \,)^{(5)} e^{(\, \hat{M}_{28} \,)^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{28} \,)^{(5)} e^{(\, \hat{M}_{28} \,)^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{28}')^{(5)} + a_{28}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{28}\left(s_{(28)}\right)\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}\left(s_{(28)}\right) - \left((a_{29}')^{(5)} + (a_{29}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{29}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{30}')^{(5)} + (a_{30}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{30}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{28}')^{(5)} - (b_{28}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{28}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}\left(s_{(28)}\right) - \left((b_{29}')^{(5)} - (b_{29}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{29}\left(s_{(28)}\right)\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{30}')^{(5)} - (b_{30}'')^{(5)}\left(G_{31}\left(s_{(28)}\right), s_{(28)}\right)\right) T_{30}\left(s_{(28)}\right)\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i \, , \, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , T_i(0) = T_i^0 \, , \, G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} \, , T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\, \hat{P}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\, \hat{Q}_{32} \,)^{(6)} e^{(\, \hat{M}_{32} \,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}\left(s_{(32)}\right) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{32}\left(s_{(32)}\right)\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}\left(s_{(32)}\right) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{33}\left(s_{(32)}\right)\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}\left(s_{(32)}\right) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}\left(T_{33}\left(s_{(32)}\right), s_{(32)}\right)\right) G_{34}\left(s_{(32)}\right)\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}\left(s_{(32)}\right) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}\left(G_{35}\left(s_{(32)}\right), s_{(32)}\right)\right) T_{32}\left(s_{(32)}\right)\right] ds_{(32)}$	

$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$

$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$

Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:
Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{36})^{(7)}, T_i^0 \leq (\hat{Q}_{36})^{(7)},$

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$

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$\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$

$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$

$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$

$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$

$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$

Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)},$

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$

$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \le (\hat{P}_{44})^{(9)}, T_i^0 \le (\hat{Q}_{44})^{(9)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{46}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{46}(s_{(44)}) \right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	

The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0 \right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0} \right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}} \right) \right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1 \right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0 \right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0} \right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173

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From which it follows that $$(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[((\hat{P}_{24})^{(4)}+G_{25}^0)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $$G_{28}(t) \leq G_{28}^0+\int_0^t\left[(a_{28})^{(5)}\left(G_{29}^0+(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\right)\right]ds_{(28)} =$$ $$\left(1+(a_{28})^{(5)}t\right)G_{29}^0+\frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t}-1\right)$$	
From which it follows that $$(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[((\hat{P}_{28})^{(5)}+G_{29}^0)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)}+(\hat{P}_{28})^{(5)}\right]$$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $$G_{32}(t) \leq G_{32}^0+\int_0^t\left[(a_{32})^{(6)}\left(G_{33}^0+(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}s_{(32)}}\right)\right]ds_{(32)} =$$ $$\left(1+(a_{32})^{(6)}t\right)G_{33}^0+\frac{(a_{32})^{(6)}(\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left(e^{(\hat{M}_{32})^{(6)}t}-1\right)$$	176
From which it follows that $$(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[((\hat{P}_{32})^{(6)}+G_{33}^0)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have 279 A

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + \left((\hat{P}_{44})^{(9)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{Q}_{44})^{(9)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)},(T_{47})^{(1)}\right),\left((G_{47})^{(2)},(T_{47})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $\left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\left((G_{47}),(T_{47})\right)$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t\{(a'_{44})^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}\left(T_{45}^{(1)},s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}\left(T_{45}^{(1)},s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)},s_{(44)}\right)|\ e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by

$(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ and $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i\ (t) = 0\ and\ T_i\ (t) = 0$

From 99 to 44 it results

$$G_i\ (t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i\ (t) \geq T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for t} > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ and $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} and G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} or G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} is bounded, from below, the same property holds for G_{45} and G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}\left((G_{47})(t), t\right)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}\left((G_{47})(t), t\right) < \varepsilon_9, T_{44}\ (t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)} (m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}\left((G_{47})(t), t\right) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a'_{13})^{(1)} + (a'_{14})^{(1)} - (a''_{13})^{(1)}(T_{14}, t) + (a''_{14})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G, t) - (b''_{14})^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)},\ if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)},\ if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)},\ if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})} \left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t} \right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq \right.$ $\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})} [e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}] + G_{15}^0 e^{-(a_{15}')^{(1)}t})$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})} \left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t} \right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})} \left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t} \right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
<u>Definition of</u> $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define	291
<u>Definition of</u> $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\big((G_{19}), t\big) - (b_{17}'')^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
<u>Definition of</u> $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
<u>Definition of</u> $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300

roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2+(\sigma_2)^{(2)}\nu^{(2)}-(a_{16})^{(2)}=0$	301
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$(m_2)^{(2)}=(\nu_1)^{(2)},(m_1)^{(2)}=(\bar{\nu}_1)^{(2)},\boldsymbol{if}\ (\nu_1)^{(2)}<(\nu_0)^{(2)}<(\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)}=\frac{G_{16}^0}{G_{17}^0}}$	306
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and analogously $(\mu_2)^{(2)}=(u_0)^{(2)},(\mu_1)^{(2)}=(u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)}<(u_1)^{(2)}$ $(\mu_2)^{(2)}=(u_1)^{(2)},(\mu_1)^{(2)}=(\bar{u}_1)^{(2)},\boldsymbol{if}\ (u_1)^{(2)}<(u_0)^{(2)}<(\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)}=\frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)}=(u_1)^{(2)},(\mu_1)^{(2)}=(u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)}<(u_0)^{(2)}$	309
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$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}\left((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)}\right)}\left[e^{\left((S_1)^{(2)}-(p_{16})^{(2)}\right)t}-e^{-(S_2)^{(2)}t}\right]+G_{18}^0 e^{-(S_2)^{(2)}t}\leq G_{18}(t)\leq\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}\left((S_1)^{(2)}-(a_{18}')^{(2)}\right)}\left[e^{(S_1)^{(2)}t}-e^{-(a_{18}')^{(2)}t}\right]+G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t}\leq T_{16}(t)\leq T_{16}^0 e^{\left((R_1)^{(2)}+(r_{16})^{(2)}\right)t}}$	313
$\frac{1}{(\mu_1)^{(2)}}T_{16}^0 e^{(R_1)^{(2)}t}\leq T_{16}(t)\leq \frac{1}{(\mu_2)^{(2)}}T_{16}^0 e^{\left((R_1)^{(2)}+(r_{16})^{(2)}\right)t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}\left((R_1)^{(2)}-(b_{18}')^{(2)}\right)}\left[e^{(R_1)^{(2)}t}-e^{-(b_{18}')^{(2)}t}\right]+T_{18}^0 e^{-(b_{18}')^{(2)}t}\leq T_{18}(t)\leq$	315

$\frac{(a_{18})^{(2)}\mathrm{T}_{16}^0}{(\mu_2)^{(2)}((\mathrm{R}_1)^{(2)}+(r_{16})^{(2)}+(\mathrm{R}_2)^{(2)})}\left[\mathrm{e}^{((\mathrm{R}_1)^{(2)}+(r_{16})^{(2)})t}-\mathrm{e}^{-(\mathrm{R}_2)^{(2)}t}\right]+\mathrm{T}_{18}^0\mathrm{e}^{-(\mathrm{R}_2)^{(2)}t}$	
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Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)}\leq-(a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}-(a_{20}^{''})^{(3)}(T_{21},t)+(a_{21}^{''})^{(3)}(T_{21},t)\leq-(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)}\leq-(b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23},t)-(b_{21}^{''})^{(3)}((G_{23}),t)\leq-(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)},(\nu_2)^{(3)},(u_1)^{(3)},(u_2)^{(3)}$: By $(\nu_1)^{(3)}>0,(\nu_2)^{(3)}<0$ and respectively $(u_1)^{(3)}>0,(u_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_1)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_1)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$ and By $(\bar{\nu}_1)^{(3)}>0,(\bar{\nu}_2)^{(3)}<0$ and respectively $(\bar{u}_1)^{(3)}>0,(\bar{u}_2)^{(3)}<0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2+(\sigma_2)^{(3)}\nu^{(3)}-(a_{20})^{(3)}=0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2+(\tau_2)^{(3)}u^{(3)}-(b_{20})^{(3)}=0$	320
Definition of $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)},(m_2)^{(3)},(\mu_1)^{(3)},(\mu_2)^{(3)}$ by $(m_2)^{(3)}=(\nu_0)^{(3)},(m_1)^{(3)}=(\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)}<(\nu_1)^{(3)}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\bar{\nu}_1)^{(3)},\boldsymbol{if}\ (\nu_1)^{(3)}<(\nu_0)^{(3)}<(\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)}=\frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)}=(\nu_1)^{(3)},(m_1)^{(3)}=(\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)}<(\nu_0)^{(3)}$	321

and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ , \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
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<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
<u>**Behavior of the solutions of equation**</u> <u>**Theorem:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}),t\big) - (b''_{25})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)}$, $\boldsymbol{if}$ $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, $\boldsymbol{if}$ $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)}$, $\boldsymbol{if}$ $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)}$, $\boldsymbol{if}$ $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}$ $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\Bigg(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\big((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\big)}\Big[e^{((S_1)^{(4)} - (p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\Big] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\big((G_{31}), t\big) - (b_{29}'')^{(5)}\big((G_{31}), t\big) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0, (\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0, (u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)},$ ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)},$	340

and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation	349

Theorem 2: If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)}, , (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \ \boldsymbol{if} \ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G^0_{32}}{G^0_{33}}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
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$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
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Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
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roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)},\ \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^0e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)},(S_2)^{(7)},(R_1)^{(7)},(R_2)^{(7)}$:- Where $(S_1)^{(7)}=(a_{36})^{(7)}(m_2)^{(7)}-(a_{36}^{'})^{(7)}$ $(S_2)^{(7)}=(a_{38})^{(7)}-(p_{38})^{(7)}$ $(R_1)^{(7)}=(b_{36})^{(7)}(\mu_2)^{(7)}-(b_{36}^{'})^{(7)}$ $(R_2)^{(7)}=(b_{38}^{'})^{(7)}-(r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)},(\sigma_2)^{(8)},(\tau_1)^{(8)},(\tau_2)^{(8)}$: $(\sigma_1)^{(8)},(\sigma_2)^{(8)},(\tau_1)^{(8)},(\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)}\leq-(a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}-(a_{40}^{''})^{(8)}(T_{41},t)+(a_{41}^{''})^{(8)}(T_{41},t)\leq-(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)}\leq-(b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(b_{40}^{''})^{(8)}((G_{43}),t)-(b_{41}^{''})^{(8)}((G_{43}),t)\leq-(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)},(\nu_2)^{(8)},(u_1)^{(8)},(u_2)^{(8)},\nu^{(8)},u^{(8)}$: By $(\nu_1)^{(8)}>0,(\nu_2)^{(8)}<0$ and respectively $(u_1)^{(8)}>0,(u_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_1)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_1)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ and	372
Definition of $(\bar{\nu}_1)^{(8)},,(\bar{\nu}_2)^{(8)},(\bar{u}_1)^{(8)},(\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)}>0,(\bar{\nu}_2)^{(8)}<0$ and respectively $(\bar{u}_1)^{(8)}>0,(\bar{u}_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_2)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_2)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ **Definition of** $(m_1)^{(8)},(m_2)^{(8)},(\mu_1)^{(8)},(\mu_2)^{(8)},(\nu_0)^{(8)}$:- If we define $(m_1)^{(8)},(m_2)^{(8)},(\mu_1)^{(8)},(\mu_2)^{(8)}$ by $(m_2)^{(8)}=(\nu_0)^{(8)},(m_1)^{(8)}=(\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)}<(\nu_1)^{(8)}$	

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$$

$$(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$$

Behavior of the solutions of equation 37 to 92 382

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \le -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \le -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \le -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \le -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T^0_{44}}{T^0_{45}}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq \frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t}\Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}}{1+(C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)}-(\nu_0)^{(1)}}{(\nu_0)^{(1)}-(\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}}{1+(C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)}-(\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}}{1+(\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)}-(\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
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If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:- $(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(3)}(t)$:- $(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case :	403

If $(a_{20}'')^{(3)} = (a_{21}'')^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b_{20}'')^{(3)} = (b_{21}'')^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a_{24}')^{(4)} - (a_{25}')^{(4)} + (a_{24}'')^{(4)}(T_{25}, t)\right) - (a_{25}'')^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

<u>Definition of</u> $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

<u>Proof</u> : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

<u>Definition of</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}\quad,\quad\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$

413 In the same manner , we get

$$\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$

414 If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case,

$$(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$$

415 If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain

$$(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$$(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)},\quad\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)},\quad\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$**, and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}, \quad \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}, \quad \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have
Definition of $\nu^{(8)}(t)$:-

$$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}, \quad \boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$$

In a completely analogous way, we obtain
Definition of $u^{(8)}(t)$:-

$$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}, \quad \boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>**Particular case :**</u>

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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<u>**Proof**</u> : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

<u>**Definition of**</u> $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \le \frac{d\nu^{(9)}}{dt} \le -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

<u>**Definition of**</u> $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \ge \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \le \nu^{(9)}(t) \le (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \le \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \le \nu^{(9)}(t) \le (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \le \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \le \nu^{(9)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \le (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$,

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$

with $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system

Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations 426

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$ 427

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$ 428

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$, 429

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$	434

$with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\,]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (z) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*})=0$. With this value , we obtain from the three first equations	
$G_{16}=\frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18}=\frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
<u>Definition and uniqueness of</u> T_{21}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*})=0$. With this value , we obtain from the three first equations $G_{20}=\frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22}=\frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
<u>Definition and uniqueness of</u> T_{25}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*})=0$. With this value , we obtain from the three first equations $G_{24}=\frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26}=\frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
<u>Definition and uniqueness of</u> T_{29}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*})=0$. With this value , we obtain from the three first equations $G_{28}=\frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}=\frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
<u>Definition and uniqueness of</u> T_{33}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*})=0$. With this value , we obtain from the three first equations $G_{32}=\frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}=\frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	499
<u>Definition and uniqueness of</u> T_{37}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*})=0$. With this value , we obtain from the three first equations $G_{36}=\frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}=\frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500

Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right] + (b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right] + (b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right] + (b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{25} such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{29} such that $\varphi((G_{31})^*) = 0$	507
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By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^{*} given by $\varphi((G_{31})^{*})=0$, T_{29}^{*} given by $f(T_{29}^{*})=0$ and $G_{28}^{*}=\frac{(a_{28})^{(5)}G_{29}^{*}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*}=\frac{(a_{30})^{(5)}G_{29}^{*}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	
$T_{28}^{*}=\frac{(b_{28})^{(5)}T_{29}^{*}}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*}=\frac{(b_{30})^{(5)}T_{29}^{*}}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*})=0$, T_{33}^{*} given by $f(T_{33}^{*})=0$ and $G_{32}^{*}=\frac{(a_{32})^{(6)}G_{33}^{*}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*}=\frac{(a_{34})^{(6)}G_{33}^{*}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*}=\frac{(b_{32})^{(6)}T_{33}^{*}}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^{*})]}$, $T_{34}^{*}=\frac{(b_{34})^{(6)}T_{33}^{*}}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*})=0$, T_{37}^{*} given by $f(T_{37}^{*})=0$ and $G_{36}^{*}=\frac{(a_{36})^{(7)}G_{37}^{*}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}^{*}=\frac{(a_{38})^{(7)}G_{37}^{*}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$ $T_{36}^{*}=\frac{(b_{36})^{(7)}T_{37}^{*}}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^{*})]}$, $T_{38}^{*}=\frac{(b_{38})^{(7)}T_{37}^{*}}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*})=0$, T_{41}^{*} given by $f(T_{41}^{*})=0$ and $G_{40}^{*}=\frac{(a_{40})^{(8)}G_{41}^{*}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42}^{*}=\frac{(a_{42})^{(8)}G_{41}^{*}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$ $T_{40}^{*}=\frac{(b_{40})^{(8)}T_{41}^{*}}{[(b_{40}^{'})^{(8)}-(b_{40}^{''})^{(8)}((G_{43})^{*})]}$, $T_{42}^{*}=\frac{(b_{42})^{(8)}T_{41}^{*}}{[(b_{42}^{'})^{(8)}-(b_{42}^{''})^{(8)}((G_{43})^{*})]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^{*} given by $\varphi((G_{47})^{*})=0$, T_{45}^{*} given by $f(T_{45}^{*})=0$ and $G_{44}^{*}=\frac{(a_{44})^{(9)}G_{45}^{*}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46}^{*}=\frac{(a_{46})^{(9)}G_{45}^{*}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b'_{44})^{(9)} - (b''_{44})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b'_{46})^{(9)} - (b''_{46})^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(1)}$ *and* $(b''_i)^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{14})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b''_i)^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -((a'_{13})^{(1)} + (p_{13})^{(1)})\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -((a'_{14})^{(1)} + (p_{14})^{(1)})\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -((a'_{15})^{(1)} + (p_{15})^{(1)})\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -((b'_{13})^{(1)} - (r_{13})^{(1)})\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(13)(j)} T_{13}^* \mathbb{G}_j)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -((b'_{14})^{(1)} - (r_{14})^{(1)})\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}(s_{(14)(j)} T_{14}^* \mathbb{G}_j)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -((b'_{15})^{(1)} - (r_{15})^{(1)})\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(15)(j)} T_{15}^* \mathbb{G}_j)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(2)}$ and $(b''_i)^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a''_{17})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b''_i)^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -((a'_{16})^{(2)} + (p_{16})^{(2)})\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^{*}) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}} (T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j} ((G_{27})^*) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)} G_{24}^* \mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)} G_{25}^* \mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)} G_{26}^* \mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)} T_{24}^* \mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)} T_{25}^* \mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)} T_{26}^* \mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS <u>**Theorem 5:**</u> If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	555
<u>**Definition of**</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}} (T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j} ((G_{31})^*) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)} G_{28}^* \mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)} G_{29}^* \mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)} G_{30}^* \mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)} T_{28}^* \mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)} T_{29}^* \mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)} T_{30}^* \mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^{*}\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^{*}\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^{*}\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^{*}\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **<u>Theorem 8:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}\ and\ (b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^{*}) = (q_{41})^{(8)} \ , \ \frac{\partial (b_i^{''})^{(8)}}{\partial G_j}\left((G_{43})^{*}\right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^{*}\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^{*}\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}\ and\ (b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i'')^{(9)}}{\partial G_j}((G_{47})^*) = s_{ij}$$

Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44

$$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^*\mathbb{T}_{45}$$ 586 B

$$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^*\mathbb{T}_{45}$$ 586 C

$$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^*\mathbb{T}_{45}$$ 586 D

$$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^*\mathbb{G}_j\right)$$ 586 E

$$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^*\mathbb{G}_j\right)$$ 586 F

$$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^*\mathbb{G}_j\right)$$ 586 G

The characteristic equation of this system is 587

$$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$$

$$\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$$

$$\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$$

$$+\left(\left((\lambda)^{(1)} + (a_{14}')^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^*\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^* + (b_{14})^{(1)}s_{(13),(13)}T_{13}^*\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$$

+

$$\left((\lambda)^{(2)}+(b_{18}')^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}')^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)}+(a_{17}')^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}')^{(2)}+(b_{17}')^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(3)}+(b_{22}')^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}')^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$$

$$+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$$

+

$((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(((\lambda)^{(4)})^{2} + ((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)})(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^{2} + ((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)})(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^{2} + ((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)})(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(((\lambda)^{(5)})^{2} + ((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)})(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^{2} + ((b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)})(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^{2} + ((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)})(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(30)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\} = 0$ +	

$$\left((\lambda)^{(6)}+(b'_{34})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a'_{34})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a'_{32})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G^*_{33}+(a_{33})^{(6)}(q_{32})^{(6)}G^*_{32}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T^*_{33}+(b_{33})^{(6)}s_{(32),(33)}T^*_{33}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a'_{33})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G^*_{32}+(a_{32})^{(6)}(q_{33})^{(6)}G^*_{33}\right)$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T^*_{33}+(b_{33})^{(6)}s_{(32),(32)}T^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2+\left((a'_{32})^{(6)}+(a'_{33})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2+\left((b'_{32})^{(6)}+(b'_{33})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2+\left((a'_{32})^{(6)}+(a'_{33})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a'_{32})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G^*_{33}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T^*_{33}+(b_{33})^{(6)}s_{(32),(34)}T^*_{32}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b'_{38})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a'_{38})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G^*_{37}+(a_{37})^{(7)}(q_{36})^{(7)}G^*_{36}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T^*_{37}+(b_{37})^{(7)}s_{(36),(37)}T^*_{37}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a'_{37})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G^*_{36}+(a_{36})^{(7)}(q_{37})^{(7)}G^*_{37}\right)$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T^*_{37}+(b_{37})^{(7)}s_{(36),(36)}T^*_{36}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2+\left((b'_{36})^{(7)}+(b'_{37})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G^*_{37}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G^*_{36}\right)$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T^*_{37}+(b_{37})^{(7)}s_{(36),(38)}T^*_{36}\right)\}=0$$

+

$$((\lambda)^{(8)} + (b'_{42})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a'_{42})^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)} G^*_{41} + (a_{41})^{(8)}(q_{40})^{(8)} G^*_{40}\right)\right]$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)}) s_{(41),(41)} T^*_{41} + (b_{41})^{(8)} s_{(40),(41)} T^*_{41}\right)$$

$$+\left(((\lambda)^{(8)} + (a'_{41})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)} G^*_{40} + (a_{40})^{(8)}(q_{41})^{(8)} G^*_{41}\right)$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)}) s_{(41),(40)} T^*_{41} + (b_{41})^{(8)} s_{(40),(40)} T^*_{40}\right)$$

$$\left(((\lambda)^{(8)})^2 + \left((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(((\lambda)^{(8)})^2 + \left((b'_{40})^{(8)} + (b'_{41})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(((\lambda)^{(8)})^2 + \left((a'_{40})^{(8)} + (a'_{41})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right) (q_{42})^{(8)} G_{42}$$

$$+((\lambda)^{(8)} + (a'_{40})^{(8)} + (p_{40})^{(8)}) \left((a_{42})^{(8)}(q_{41})^{(8)} G^*_{41} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)} G^*_{40}\right)$$

$$\left(((\lambda)^{(8)} + (b'_{40})^{(8)} - (r_{40})^{(8)}) s_{(41),(42)} T^*_{41} + (b_{41})^{(8)} s_{(40),(42)} T^*_{40}\right)\} = 0$$

+

$$((\lambda)^{(9)} + (b'_{46})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a'_{46})^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)} G^*_{45} + (a_{45})^{(9)}(q_{44})^{(9)} G^*_{44}\right)\right]$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)}) s_{(45),(45)} T^*_{45} + (b_{45})^{(9)} s_{(44),(45)} T^*_{45}\right)$$

$$+\left(((\lambda)^{(9)} + (a'_{45})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)} G^*_{44} + (a_{44})^{(9)}(q_{45})^{(9)} G^*_{45}\right)$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)}) s_{(45),(44)} T^*_{45} + (b_{45})^{(9)} s_{(44),(44)} T^*_{44}\right)$$

$$\left(((\lambda)^{(9)})^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$\left(((\lambda)^{(9)})^2 + \left((b'_{44})^{(9)} + (b'_{45})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$+\left(((\lambda)^{(9)})^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right) (q_{46})^{(9)} G_{46}$$

$$+((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)}) \left((a_{46})^{(9)}(q_{45})^{(9)} G^*_{45} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)} G^*_{44}\right)$$

$$\left(((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)}) s_{(45),(46)} T^*_{45} + (b_{45})^{(9)} s_{(44),(46)} T^*_{44}\right)\} = 0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION TWENTY SEVEN

Holographic Description Of A Quantum Black Hole On A Computer

INTRODUCTION—VARIABLES USED

Communications in Mathematical Physics November 2006, Volume 267, Issue 3, pp 783-800 First online: 17 August 2006 Moduli Space of BPS Walls in Supersymmetric Gauge Theories Norisuke Sakai , Yisong Yang

(1) Existence and uniqueness of the solution are proved for (e) the 'master equation' derived from (e) the BPS equation for (e) the vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges.
(2) This proof establishes that (eb) the solutions of the BPS equations are completely characterized by (e) the moduli matrices divided by (e&eb) the V-equivalence relation for (e) the gauge theory at finite gauge couplings.
(3) Therefore the moduli space at finite gauge couplings is (=) topologically the same manifold as that at infinite gauge coupling, where (e) the gauged linear sigma model reduces to (e&eb) a nonlinear sigma model.
(4) The proof is extended to the U (N C) gauge theory with (e&eb) N F hypermultiplets in the fundamental representation, provided (e) the moduli matrix of the domain wall solution is (=) U (1)-factorizable.
(5) Thus the dimension of the moduli space of U (N C) gauge theory is bounded from (e) below by (e) the dimension of the U (1)-factorizable part of the moduli space.
(6) They also obtain sharp estimates of the asymptotic exponential decay which depend on (=) both the gauge coupling and the hypermultiplet mass differences. Communicated by N.A. Nekrasov (Separate models given)

Holographic description of a quantum black hole on a computer Masanori Hanada1, 2, 3,*, Yoshifumi Hyakutake4, Goro Ishiki1, Jun Nishimura5,6 Science 23 May 2014: Vol. 344, Issue 6186, pp. 882-885 DOI: 10.1126/science.1250122

(7) Black holes have been predicted to radiate particles and eventually evaporate (e&eb) which has led to (eb) the information loss paradox and implies (eb) that the fundamental laws of quantum mechanics may be (=) violated.
(8) Superstring theory, a consistent theory of quantum gravity, provides (eb) a possible solution to the paradox if (e) evaporating black holes can actually be described in terms of (e&eb) standard quantum mechanical systems, as conjectured from (e) the theory.
(9) Here, authors test this conjecture by calculating the mass of a black hole in (e&eb) the

corresponding quantum mechanical system numerically.

(10) Results agree well with (eb) the prediction from gravity theory, including (e) the leading quantum gravity correction.

(11) Ability to simulate (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics.

(12) Quantum mechanics and (e&eb) gravity can seem to contradict each other.

(13) Superstring theory may provide (eb) a route to reconcile the two, thanks to (e) the gauge/gravity duality conjecture, which allows (eb) the system to be described mathematically.

(14) However, this conjecture has yet to be formally confirmed. Hanada et al. (see the Perspective by Maldacena) performed a simulation of (e&eb) the dual gauge theory in the parameter regime that corresponds to (e&eb) a quantum black hole.

(15) Their results agree with (eb) a prediction for an evaporating black hole, including (e) quantum gravity corrections, confirming that (eb) the dual gauge theory indeed provides (eb) a complete description of the quantum nature of (e) the evaporating black hole. Science, this issue p. 882; see also p. 806

NOTATION

Module One

Existence and uniqueness of the solution are proved for (e) the 'master equation' derived from (e) the BPS equation for (e) the vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges

G_{13} : Category one of **Existence and uniqueness of the solution;** 'master equation' derived from (e) the BPS equation for (e) the vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of 'master equation' derived from (e) the BPS equation for (e) the vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges **;Existence and uniqueness of the solution**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Existence and uniqueness of the solution are proved for the 'master equation' derived from (e) the BPS equation for (e) the vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges

G_{16} : Category one of BPS equation for (e) the vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of Existence and uniqueness of the solution are proved for the 'master equation'

T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three Existence and uniqueness of the solution are proved for the 'master equation' derived from the BPS equation for (e) the vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges	
G_{20} : Category one of **Existence and uniqueness of the solution are proved for the 'master equation' derived from the BPS equation;** vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of vector multiplet scalar in the U(1) gauge theory with (e&eb) N F charged matter hypermultiplets with eight supercharges **;Existence and uniqueness of the solution are proved for the 'master equation' derived from the BPS equation** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Existence and uniqueness of the solution are proved for the 'master equation' derived from the BPS equation for the vector multiplet scalar in the U(1) gauge theory with N F charged matter hypermultiplets with eight supercharges	
G_{24} : Category one of **Existence and uniqueness of the solution are proved for the 'master equation' derived from the BPS equation for the vector multiplet scalar in the U(1) gauge theory;** N F charged matter hypermultiplets with eight supercharges G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of N F charged matter hypermultiplets with eight supercharges; **Existence and uniqueness of the solution are proved for the 'master equation' derived from the BPS equation for the vector multiplet scalar in the U(1) gauge theory** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five This proof establishes that (eb) the solutions of the BPS equations are completely characterized by (e) the moduli matrices divided by (e&eb) the V-equivalence relation for (e) the gauge theory at finite gauge couplings	
G_{28} : Category one of Existence and uniqueness of the solution are proved for the 'master equation' derived	

from the BPS equation for the vector multiplet scalar in the U(1) gauge theory with N F charged matter hypermultiplets with eight supercharges G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of solutions of the BPS equations are completely characterized by (e) the moduli matrices divided by (e&eb) the V-equivalence relation for (e) the gauge theory at finite gauge couplings T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six This proof establishes that the solutions of the BPS equations are completely characterized by (e) the moduli matrices divided by (e&eb) the V-equivalence relation for (e) the gauge theory at finite gauge couplings	
G_{32} : Category one of **solutions of the BPS equations are completely characterized;** moduli matrices divided by (e&eb) the V-equivalence relation for (e) the gauge theory at finite gauge couplings G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of moduli matrices divided by (e&eb) the V-equivalence relation for (e) the gauge theory at finite gauge couplings **;solutions of the BPS equations are completely characterized** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven This proof establishes that the solutions of the BPS equations are completely characterized by the moduli matrices divided by (e&eb) the V-equivalence relation for (e) the gauge theory at finite gauge couplings	
G_{36} : Category one of **the solutions of the BPS equations are completely characterized by the moduli matrices divided;** V-equivalence relation for (e) the gauge theory at finite gauge couplings G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of V-equivalence relation for (e) the gauge theory at finite gauge couplings; **the solutions of the BPS equations are completely characterized by the moduli matrices divided** T_{37} : Category two of SAS T_{38} : Category three of SAS	

Module eight This proof establishes that the solutions of the BPS equations are completely characterized by the moduli matrices divided by the V-equivalence relation for (e) the gauge theory at finite gauge couplings	
G_{40} : Category one of **solutions of the BPS equations are completely characterized by the moduli matrices divided by the V-equivalence relation;** gauge theory at finite gauge couplings G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of gauge theory at finite gauge couplings; **solutions of the BPS equations are completely characterized by the moduli matrices divided by the V-equivalence relation** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine Therefore the moduli space at finite gauge couplings is (=) topologically the same manifold as that at infinite gauge coupling, where (e) the gauged linear sigma model reduces to (e&eb) a nonlinear sigma model	
G_{44} : Category one of moduli space at finite gauge couplings G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of topologically the same manifold as that at infinite gauge coupling, where (e) the gauged linear sigma model reduces to (e&eb) a nonlinear sigma model T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)},(a_{14})^{(1)},(a_{15})^{(1)},(b_{13})^{(1)},(b_{14})^{(1)},(b_{15})^{(1)}\ (a_{16})^{(2)},(a_{17})^{(2)},(a_{18})^{(2)}\ (b_{16})^{(2)},(b_{17})^{(2)},(b_{18})^{(2)}$: $(a_{20})^{(3)},(a_{21})^{(3)},(a_{22})^{(3)}$, $(b_{20})^{(3)},(b_{21})^{(3)},(b_{22})^{(3)}$ $(a_{24})^{(4)},(a_{25})^{(4)},(a_{26})^{(4)},(b_{24})^{(4)},(b_{25})^{(4)},(b_{26})^{(4)},(b_{28})^{(5)},(b_{29})^{(5)},(b_{30})^{(5)},(a_{28})^{(5)},(a_{29})^{(5)},(a_{30})^{(5)}$, $(a_{32})^{(6)},(a_{33})^{(6)},(a_{34})^{(6)},(b_{32})^{(6)},(b_{33})^{(6)},(b_{34})^{(6)}$ $(a_{36})^{(7)},(a_{37})^{(7)},(a_{38})^{(7)},(b_{36})^{(7)},(b_{37})^{(7)},(b_{38})^{(7)}$ $(a_{40})^{(8)},(a_{41})^{(8)},(a_{42})^{(8)},(b_{40})^{(8)},(b_{41})^{(8)},(b_{42})^{(8)}$ $(a_{44})^{(9)},(a_{45})^{(9)},(a_{46})^{(9)},(b_{44})^{(9)},(b_{45})^{(9)},(b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)},(a'_{14})^{(1)},(a'_{15})^{(1)},(b'_{13})^{(1)},(b'_{14})^{(1)},(b'_{15})^{(1)},(a'_{16})^{(2)},(a'_{17})^{(2)},(a'_{18})^{(2)},\ (b'_{16})^{(2)},(b'_{17})^{(2)},(b'_{18})^{(2)}$ $,(a'_{20})^{(3)},(a'_{21})^{(3)},(a'_{22})^{(3)},(b'_{20})^{(3)},(b'_{21})^{(3)},(b'_{22})^{(3)}$ $(a'_{24})^{(4)},(a'_{25})^{(4)},(a'_{26})^{(4)},(b'_{24})^{(4)},(b'_{25})^{(4)},(b'_{26})^{(4)},(b'_{28})^{(5)},(b'_{29})^{(5)},(b'_{30})^{(5)}\ (a'_{28})^{(5)},(a'_{29})^{(5)},(a'_{30})^{(5)}$,	

$(a_{32}^{'})^{(6)}, (a_{33}^{'})^{(6)}, (a_{34}^{'})^{(6)}, (b_{32}^{'})^{(6)}, (b_{33}^{'})^{(6)}, (b_{34}^{'})^{(6)}$ $(a_{36}^{'})^{(7)}, (a_{37}^{'})^{(7)}, (a_{38}^{'})^{(7)}, (b_{36}^{'})^{(7)}, (b_{37}^{'})^{(7)}, (b_{38}^{'})^{(7)}$, $(a_{40}^{'})^{(8)}, (a_{41}^{'})^{(8)}, (a_{42}^{'})^{(8)}, (b_{40}^{'})^{(8)}, (b_{41}^{'})^{(8)}, (b_{42}^{'})^{(8)}$, $(a_{44}^{'})^{(9)}, (a_{45}^{'})^{(9)}, (a_{46}^{'})^{(9)}, (b_{44}^{'})^{(9)}, (b_{45}^{'})^{(9)}, (b_{46}^{'})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G,t)\right]T_{15}$	6
$+(a_{13}^{''})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	

$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a''_{24})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	*38*

$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	39
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	42
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a_{16}'')^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}'')^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}'')^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a_{40}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{41}'')^{(8,8)}(T_{41},t)}$ $\boxed{+(a_{42}'')^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b_{13}')^{(1)} \boxed{-(b_{13}'')^{(1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b_{14}')^{(1)} \boxed{-(b_{14}'')^{(1)}(G,t)} \boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b_{15}')^{(1)} \boxed{-(b_{15}'')^{(1)}(G,t)} \boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	*60*
Where $\boxed{-(b_{13}'')^{(1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3	

$-(b''_{37})^{(7,7,)}(G_{39},t)$, $-(b''_{36})^{(7,7,)}(G_{39},t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8)}(G_{43},t)$ $-(b''_{41})^{(8,8)}(G_{43},t)$ $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[\begin{matrix}(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17},t)+(a''_{13})^{(1,1,)}(T_{14},t)+(a''_{20})^{(3,3,3)}(T_{21},t)\\+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)\\+(a''_{36})^{(7,7,7)}(T_{37},t)+(a''_{40})^{(8,8,8)}(T_{41},t)+(a''_{44})^{(9,9)}(T_{45},t)\end{matrix}\right]G_{16}$	61
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[\begin{matrix}(a'_{17})^{(2)}+(a''_{17})^{(2)}(T_{17},t)+(a''_{14})^{(1,1,)}(T_{14},t)+(a''_{21})^{(3,3,3)}(T_{21},t)\\+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)\\+(a''_{37})^{(7,7,7)}(T_{37},t)+(a''_{41})^{(8,8,8)}(T_{41},t)+(a''_{45})^{(9,9)}(T_{45},t)\end{matrix}\right]G_{17}$	62
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[\begin{matrix}(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17},t)+(a''_{15})^{(1,1,)}(T_{14},t)+(a''_{22})^{(3,3,3)}(T_{21},t)\\+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)\\+(a''_{38})^{(7,7,7)}(T_{37},t)+(a''_{42})^{(8,8,8)}(T_{41},t)+(a''_{46})^{(9,9)}(T_{45},t)\end{matrix}\right]G_{18}$	63
Where $+(a''_{16})^{(2)}(T_{17},t)$, $+(a''_{17})^{(2)}(T_{17},t)$, $+(a''_{18})^{(2)}(T_{17},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,)}(T_{14},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3 $+(a''_{44})^{(9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9)}(T_{45},t)$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[\begin{matrix}(b'_{16})^{(2)}-(b''_{16})^{(2)}(G_{19},t)-(b''_{13})^{(1,1,)}(G,t)-(b''_{20})^{(3,3,3,)}(G_{23},t)\\-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)\\-(b''_{36})^{(7,7,7)}(G_{39},t)-(b''_{40})^{(8,8,8)}(G_{43},t)-(b''_{44})^{(9,9)}(G_{47},t)\end{matrix}\right]T_{16}$	64

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{17}$$	65
$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{18}$$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{20}$$	67
$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{21}$$	68
$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{22}$$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$+(a''_{16})^{(2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3

$+(a''_{13})^{(1,1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3

$+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3

$+(a''_{40})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3

$+(a''_{44})^{(9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt}=(b_{20})^{(3)}T_{21}-\left[\begin{matrix}(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23},t)-(b''_{16})^{(2,2,2)}(G_{19},t)-(b''_{13})^{(1,1,1,)}(G,t)\\-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)\\-(b''_{36})^{(7,7,7,7)}(G_{39},t)-(b''_{40})^{(8,8,8,8)}(G_{43},t)-(b''_{44})^{(9,9,9)}(G_{47},t)\end{matrix}\right]T_{20}$$ 70

$$\frac{dT_{21}}{dt}=(b_{21})^{(3)}T_{20}-\left[\begin{matrix}(b'_{21})^{(3)}-(b''_{21})^{(3)}(G_{23},t)-(b''_{17})^{(2,2,2)}(G_{19},t)-(b''_{14})^{(1,1,1,)}(G,t)\\-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)\\-(b''_{37})^{(7,7,7,7)}(G_{39},t)-(b''_{41})^{(8,8,8,8)}(G_{43},t)-(b''_{45})^{(9,9,9)}(G_{47},t)\end{matrix}\right]T_{21}$$ 71

$$\frac{dT_{22}}{dt}=(b_{22})^{(3)}T_{21}-\left[\begin{matrix}(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23},t)-(b''_{18})^{(2,2,2)}(G_{19},t)-(b''_{15})^{(1,1,1,)}(G,t)\\-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)\\-(b''_{38})^{(7,7,7,7)}(G_{39},t)-(b''_{42})^{(8,8,8,8)}(G_{43},t)-(b''_{46})^{(9,9,9)}(G_{47},t)\end{matrix}\right]T_{22}$$ 72

$-(b''_{20})^{(3)}(G_{23},t)$, $-(b''_{21})^{(3)}(G_{23},t)$, $-(b''_{22})^{(3)}(G_{23},t)$ *are first detrition coefficients for category 1, 2 and 3*

$-(b''_{16})^{(2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2)}(G_{19},t)$ *are second detrition coefficients for category 1, 2 and 3*

$-(b''_{13})^{(1,1,1,)}(G,t)$, $-(b''_{14})^{(1,1,1,)}(G,t)$, $-(b''_{15})^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3*

$-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3*

$-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3*

$-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[\begin{matrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{25} \qquad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[\begin{matrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{26} \qquad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{28} \qquad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{29} \qquad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{30} \qquad 81$$

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation*

$coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ $are\ third\ augmentation$ $coefficient\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\ \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\ \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\ \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{30}$	84
$where$ $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ $are\ first\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ $are\ second\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition	

coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{32} \quad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)}\boxed{+(a''_{33})^{(6)}(T_{33},t)}\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)}\boxed{+(a''_{34})^{(6)}(T_{33},t)}\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{34} \quad 87$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$

seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$

Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b_{33}^{'})^{(6)} \boxed{-(b_{33}^{''})^{(6)}(G_{35},t)} \boxed{-(b_{29}^{''})^{(5,5,5)}(G_{31},t)} \boxed{-(b_{25}^{''})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}^{''})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33} \qquad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b_{34}^{'})^{(6)} \boxed{-(b_{34}^{''})^{(6)}(G_{35},t)} \boxed{-(b_{30}^{''})^{(5,5,5)}(G_{31},t)} \boxed{-(b_{26}^{''})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}^{''})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34} \qquad 90$$

$\boxed{-(b_{32}^{''})^{(6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{28}^{''})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{24}^{''})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a_{36}^{'})^{(7)} \boxed{+(a_{36}^{''})^{(7)}(T_{37},t)} \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13} \qquad 91$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a_{37}^{'})^{(7)} \boxed{+(a_{37}^{''})^{(7)}(T_{37},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14} \qquad 92$$

$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	93
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	95
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second	

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t) + (a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t) + (a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{37},t) + (a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t) + (a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t) + (a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t) + (a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t) \end{matrix} \right] G_{15}$	
Where $+(a''_{44})^{(9)}(T_{45},t)$, $+(a''_{45})^{(9)}(T_{45},t)$, $+(a''_{46})^{(9)}(T_{37},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b_{44}')^{(9)}\boxed{-(b_{44}'')^{(9)}(G_{47},t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$	
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b_{45}')^{(9)}\boxed{-(b_{45}'')^{(9)}(G_{47},t)} \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$	
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}')^{(9)}\boxed{-(b_{46}'')^{(9)}(G_{47},t)} \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$	
Where $\boxed{-(b_{44}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3	

$-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b'_i)^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\lvert(a''_i)^{(1)}(T'_{14},t) - (a''_i)^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T'_{14}\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b''_i)^{(1)}(G',t) - (b''_i)^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a''_i)^{(1)}(T'_{14},t)$ and $(a''_i)^{(1)}(T_{14},t)$. (T'_{14},t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a''_i)^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a''_i)^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a'_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t) \le (p_i)^{(2)} \le (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \le (r_i)^{(2)} \le (b_i')^{(2)} \le (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}((G_{19}),t) = (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\|(a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t)\| \le (\hat{k}_{16})^{(2)}\|T_{17} - T_{17}'\|e^{-(\hat{M}_{16})^{(2)}t}$	107
$\|(b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}((G_{19}),t)\| < (\hat{k}_{16})^{(2)}\|\|(G_{19}) - (G_{19})'\|\|e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i')^{(2)} + \ (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)}\,(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i')^{(2)} + \ (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \le (p_i)^{(3)} \le (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \le \ (r_i)^{(3)} \le (b_i')^{(3)} \le (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty} (a_i'')^{(3)}\,(T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty} (b_i'')^{(3)}\,(G_{23}, t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20,21,22}$	113
They satisfy Lipschitz condition: $\lvert(a_i'')^{(3)}(T_{21}', t) - (a_i'')^{(3)}(T_{21}, t)\rvert \le (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)} t}$ $\lvert(b_i'')^{(3)}(G_{23}{}', t) - (b_i'')^{(3)}(G_{23}, t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}{}'\rvert\lvert e^{-(\hat{M}_{20})^{(3)} t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}', t)$ and $(a_i'')^{(3)}(T_{21}, t)$. (T_{21}', t) And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)},$ are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} \ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)},\ (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. <u>Definition of</u> $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25}, t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}), t) \leq\ (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2 \to \infty} (a_i^{''})^{(4)} (T_{25}, t) = (p_i)^{(4)}$ $\lim_{G \to \infty} (b_i^{''})^{(4)} ((G_{27}), t) = (r_i)^{(4)}$ <u>Definition of</u> $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	118
They satisfy Lipschitz condition: $\|(a_i^{''})^{(4)}(T_{25}^{'}, t) - (a_i^{''})^{(4)}(T_{25}, t)\| \leq (\hat{k}_{24})^{(4)} \|T_{25} - T_{25}^{'}\| e^{-(\hat{M}_{24})^{(4)} t}$ $\|(b_i^{''})^{(4)}((G_{27})^{'}, t) - (b_i^{''})^{(4)}((G_{27}), t)\| < (\hat{k}_{24})^{(4)} \|\|(G_{27}) - (G_{27})^{'}\|\| e^{-(\hat{M}_{24})^{(4)} t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'}, t)$ and $(a_i^{''})^{(4)}(T_{25}, t)$. $(T_{25}^{'}, t)$ and (T_{25}, t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} , \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

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Where we suppose	
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system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (EEEEEEE) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}$, $\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
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Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
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They satisfy Lipschitz condition:	

$\lvert (a_i'')^{(9)}(T_{45}',t) - (a_i'')^{(9)}(T_{45},t) \rvert \leq (\hat{k}_{44})^{(9)} \lvert T_{45} - T_{45}' \rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert (b_i'')^{(9)}((G_{47})',t) - (b_i'')^{(9)}((G_{47}),t) \rvert < (\hat{k}_{44})^{(9)} \lvert\lvert (G_{47}) - (G_{47})' \rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
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<u>Definition of</u> $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
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$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$,$T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)} (T_{17}(s_{(16)}), s_{(16)}) \right) G_{16}(s_{(16)}) \right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)} (T_{17}(s_{(16)}), s_{(17)}) \right) G_{17}(s_{(16)}) \right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0\le(\hat{P}_{32})^{(6)}\ ,T_i^0\le(\hat{Q}_{32})^{(6)},$	
$0\le G_i(t)-G_i^0\le(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$	
$0\le T_i(t)-T_i^0\le(\hat{Q}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$	
By $\bar{G}_{32}(t)=G_{32}^0+\int_0^t\left[(a_{32})^{(6)}G_{33}(s_{(32)})-\left((a'_{32})^{(6)}+a''_{32})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{32}(s_{(32)})\right]ds_{(32)}$	164
$\bar{G}_{33}(t)=G_{33}^0+\int_0^t\left[(a_{33})^{(6)}G_{32}(s_{(32)})-\left((a'_{33})^{(6)}+(a''_{33})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{33}(s_{(32)})\right]ds_{(32)}$	
$\bar{G}_{34}(t)=G_{34}^0+\int_0^t\left[(a_{34})^{(6)}G_{33}(s_{(32)})-\left((a'_{34})^{(6)}+(a''_{34})^{(6)}(T_{33}(s_{(32)}),s_{(32)})\right)G_{34}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{32}(t)=T_{32}^0+\int_0^t\left[(b_{32})^{(6)}T_{33}(s_{(32)})-\left((b'_{32})^{(6)}-(b''_{32})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{32}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{33}(t)=T_{33}^0+\int_0^t\left[(b_{33})^{(6)}T_{32}(s_{(32)})-\left((b'_{33})^{(6)}-(b''_{33})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{33}(s_{(32)})\right]ds_{(32)}$	
$\bar{T}_{34}(t)=T_{34}^0+\int_0^t\left[(b_{34})^{(6)}T_{33}(s_{(32)})-\left((b'_{34})^{(6)}-(b''_{34})^{(6)}(G_{35}(s_{(32)}),s_{(32)})\right)T_{34}(s_{(32)})\right]ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i:\mathbb{R}_+\to\mathbb{R}_+$ which satisfy	
$G_i(0)=G_i^0\ ,\ T_i(0)=T_i^0\ ,\ G_i^0\le(\hat{P}_{36})^{(7)}\ ,T_i^0\le(\hat{Q}_{36})^{(7)},$	
$0\le G_i(t)-G_i^0\le(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$	
$0\le T_i(t)-T_i^0\le(\hat{Q}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$	
By $\bar{G}_{36}(t)=G_{36}^0+\int_0^t\left[(a_{36})^{(7)}G_{37}(s_{(36)})-\left((a'_{36})^{(7)}+a''_{36})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right)G_{36}(s_{(36)})\right]ds_{(36)}$	165
$\bar{G}_{37}(t)=G_{37}^0+\int_0^t\left[(a_{37})^{(7)}G_{36}(s_{(36)})-\left((a'_{37})^{(7)}+(a''_{37})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right)G_{37}(s_{(36)})\right]ds_{(36)}$	
$\bar{G}_{38}(t)=G_{38}^0+\int_0^t\left[(a_{38})^{(7)}G_{37}(s_{(36)})-\left((a'_{38})^{(7)}+(a''_{38})^{(7)}(T_{37}(s_{(36)}),s_{(36)})\right)G_{38}(s_{(36)})\right]ds_{(36)}$	
$\bar{T}_{36}(t)=T_{36}^0+\int_0^t\left[(b_{36})^{(7)}T_{37}(s_{(36)})-\left((b'_{36})^{(7)}-(b''_{36})^{(7)}(G_{39}(s_{(36)}),s_{(36)})\right)T_{36}(s_{(36)})\right]ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By

$$\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$$

$$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$$

$$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$$

$$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$$

$$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$$

$$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$$

Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$

The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 167

$$G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$$

$$(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$$

From which it follows that 168

$$(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[((\hat{P}_{13})^{(1)} + G_{14}^0) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$$

(G_i^0) is as defined in the statement of theorem 1

Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$

The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that

$$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$$ 169

$$(1 + (a_{16})^{(2)} t) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$$

From which it follows that 170

$$(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[((\hat{P}_{16})^{(2)} + G_{17}^0) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$$

Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$

The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that 171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0) e^{-(\hat{M}_{24})^{(4)} t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left[\left((\hat{P}_{24})^{(4)} + G_{25}^0 \right) e^{\left(-\frac{(\hat{P}_{24})^{(4)} + G_{25}^0}{G_{25}^0} \right)} + (\hat{P}_{24})^{(4)} \right]$ (G_i^0) is as defined in the statement of theorem 4	174
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<u>Remark 22:</u> There does not exist any t where $G_i\ (t) = 0$ *and* $T_i\ (t) = 0$ it results $G_i\ (t) \geq G_i^0 e^{\left[-\int_0^t\{(a_i^{'})^{(5)}-(a_i^{''})^{(5)}(T_{29}(s_{(28)}),s_{(28)})\}ds_{(28)}\right]} \geq 0$ $T_i\ (t) \geq T_i^0 e^{(-(b_i^{'})^{(5)}t)} > 0$ for $\mathrm{t} > 0$	239
<u>Definition of</u> $\left((\widehat{M}_{28})^{(5)}\right)_1, \left((\widehat{M}_{28})^{(5)}\right)_2$ *and* $\left((\widehat{M}_{28})^{(5)}\right)_3$: **<u>Remark 23:</u>** if G_{28} is bounded, the same property have also G_{29} *and* G_{30} . indeed if $G_{28} < (\widehat{M}_{28})^{(5)}$ it follows $\frac{dG_{29}}{dt} \leq \left((\widehat{M}_{28})^{(5)}\right)_1 - (a_{29}^{'})^{(5)}G_{29}$ and by integrating $G_{29} \leq \left((\widehat{M}_{28})^{(5)}\right)_2 = G_{29}^0 + 2(a_{29})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_1/(a_{29}^{'})^{(5)}$ In the same way , one can obtain $G_{30} \leq \left((\widehat{M}_{28})^{(5)}\right)_3 = G_{30}^0 + 2(a_{30})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_2/(a_{30}^{'})^{(5)}$ If G_{29} *or* G_{30} is bounded, the same property follows for G_{28} , G_{30} and G_{28} , G_{29} respectively.	240
<u>Remark 24:</u> If G_{28} *is* bounded, from below, the same property holds for G_{29} *and* G_{30} . The proof is analogous with the preceding one. An analogous property is true if G_{29} is bounded from below.	241
<u>Remark 25:</u> If T_{28} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(5)}((G_{31})(t),t)) = (b_{29}^{'})^{(5)}$ then $T_{29} \to \infty$. **<u>Definition of</u>** $(m)^{(5)}$ and ε_5 : Indeed let t_5 be so that for $t > t_5$	242

$(b_{29})^{(5)} - (b_i^{''})^{(5)}((G_{31})(t),t) < \varepsilon_5, T_{28}\ (t) > (m)^{(5)}$	
Then $\frac{dT_{29}}{dt} \geq (a_{29})^{(5)}(m)^{(5)} - \varepsilon_5 T_{29}$ which leads to $T_{29}\ \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{\varepsilon_5}\right)(1-e^{-\varepsilon_5 t}) + T_{29}^0 e^{-\varepsilon_5 t}$ If we take t such that $e^{-\varepsilon_5 t} = \frac{1}{2}$ it results $T_{29}\ \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{2}\right),\quad t = log\frac{2}{\varepsilon_5}$ By taking now ε_5 sufficiently small one sees that T_{29} is unbounded. The same property holds for T_{30} if $\lim_{t\to\infty}(b_{30}^{''})^{(5)}\left((G_{31})(t),t\right) = (b_{30}^{'})^{(5)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations Analogous inequalities hold also for $G_{33}\ ,G_{34},T_{32},T_{33},T_{34}$	243
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$G_{32}^{(2)} \lvert (a_{32}'')^{(6)}(T_{33}^{(1)}, s_{(32)}) - (a_{32}'')^{(6)}(T_{33}^{(2)}, s_{(32)}) \rvert \; e^{-(\widehat{M}_{32})^{(6)} s_{(32)}} e^{(\widehat{M}_{32})^{(6)} s_{(32)}} \} ds_{(32)}$ Where $s_{(32)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$ From the hypotheses it follows	
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Remark 27: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{ (a_i')^{(6)} - (a_i'')^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \} ds_{(32)} \right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(6)} t)} > 0$ for $\mathrm{t} > 0$	250
Definition of $\left((\widehat{M}_{32})^{(6)} \right)_1, \left((\widehat{M}_{32})^{(6)} \right)_2$ *and* $\left((\widehat{M}_{32})^{(6)} \right)_3$: **Remark 28:** if G_{32} is bounded, the same property have also G_{33} *and* G_{34} . indeed if $G_{32} < (\widehat{M}_{32})^{(6)}$ it follows $\frac{dG_{33}}{dt} \leq \left((\widehat{M}_{32})^{(6)} \right)_1 - (a_{33}')^{(6)} G_{33}$ and by integrating $G_{33} \leq \left((\widehat{M}_{32})^{(6)} \right)_2 = G_{33}^0 + 2(a_{33})^{(6)} \left((\widehat{M}_{32})^{(6)} \right)_1 / (a_{33}')^{(6)}$ In the same way , one can obtain $G_{34} \leq \left((\widehat{M}_{32})^{(6)} \right)_3 = G_{34}^0 + 2(a_{34})^{(6)} \left((\widehat{M}_{32})^{(6)} \right)_2 / (a_{34}')^{(6)}$ If G_{33} *or* G_{34} is bounded, the same property follows for G_{32} , G_{34} and G_{32} , G_{33} respectively.	251
Remark 29: If G_{32} *is* bounded, from below, the same property holds for G_{33} *and* G_{34} . The proof is analogous with the preceding one. An analogous property is true if G_{33} is bounded from below.	252
Remark 30: If T_{32} is bounded from below and $\lim_{t \to \infty} ((b_i'')^{(6)} ((G_{35})(t), t)) = (b_{33}')^{(6)}$ then $T_{33} \to \infty$. **Definition of** $(m)^{(6)}$ and ε_6 :	253

Indeed let t_6 be so that for $t > t_6$ $(b_{33})^{(6)} - (b_i'')^{(6)}\big((G_{35})(t), t\big) < \varepsilon_6, T_{32}\,(t) > (m)^{(6)}$	
Then $\frac{dT_{33}}{dt} \geq (a_{33})^{(6)}(m)^{(6)} - \varepsilon_6 T_{33}$ which leads to $T_{33} \geq \left(\frac{(a_{33})^{(6)}(m)^{(6)}}{\varepsilon_6}\right)(1 - e^{-\varepsilon_6 t}) + T_{33}^0 e^{-\varepsilon_6 t}$ If we take t such that $e^{-\varepsilon_6 t} = \frac{1}{2}$ it results $T_{33} \geq \left(\frac{(a_{33})^{(6)}(m)^{(6)}}{2}\right), \quad t = log\frac{2}{\varepsilon_6}$ By taking now ε_6 sufficiently small one sees that T_{33} is unbounded. The same property holds for T_{34} if $\lim_{t\to\infty}(b_{34}'')^{(6)}\big((G_{35})(t), t(t), t\big) = (b_{34}')^{(6)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	254
Analogous inequalities hold also for $G_{37}, G_{38}, T_{36}, T_{37}, T_{38}$ It is now sufficient to take $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$ and to choose $(\widehat{P}_{36})^{(7)}$ and $(\widehat{Q}_{36})^{(7)}$ large to have	255
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$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\big((\hat{Q}_{36})^{(7)} + T_j^0\big)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{36})^{(7)}\right] \leq (\hat{Q}_{36})^{(7)}$	257
In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(\big((G_{39})^{(1)}, (T_{39})^{(1)}\big), \big((G_{39})^{(2)}, (T_{39})^{(2)}\big)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+} \lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{36})^{(7)}t}, \max_{t\in\mathbb{R}_+} \lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{36})^{(7)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{39})}, \widetilde{(T_{39})} : \big(\widetilde{(G_{39})}, \widetilde{(T_{39})}\big) = \mathcal{A}^{(7)}((G_{39}), (T_{39}))$ It results $\lvert \tilde{G}_{36}^{(1)} - \tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{36})^{(7)} \lvert G_{37}^{(1)} - G_{37}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}} e^{(\hat{M}_{36})^{(7)}s_{(36)}}\, ds_{(36)} +$ $\int_0^t\{(a_{36}')^{(7)}\lvert G_{36}^{(1)} - G_{36}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}} e^{-(\hat{M}_{36})^{(7)}s_{(36)}} +$ $(a_{36}'')^{(7)}\big(T_{37}^{(1)}, s_{(36)}\big)\lvert G_{36}^{(1)} - G_{36}^{(2)}\rvert e^{-(\hat{M}_{36})^{(7)}s_{(36)}} e^{(\hat{M}_{36})^{(7)}s_{(36)}} +$	258

$G_{36}^{(2)}\|(a_{36}'')^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)-(a_{36}'')^{(7)}\left(T_{37}^{(2)},s_{(36)}\right)\|\ e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	
$\left\|(G_{39})^{(1)}-(G_{39})^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}t}\leq$ $\frac{1}{(\widehat{M}_{36})^{(7)}}\left((a_{36})^{(7)}+\ (a_{36}')^{(7)}+(\widehat{A}_{36})^{(7)}+(\widehat{P}_{36})^{(7)}(\widehat{k}_{36})^{(7)}\right)d\left(\left((G_{39})^{(1)},(T_{39})^{(1)};\ (G_{39})^{(2)},(T_{39})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	259
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Remark 32: There does not exist any t where $G_i\ (t)=0$ *and* $T_i\ (t)=0$ it results $G_i\ (t)\geq G_i^0 e^{\left[-\int_0^t\{(a_i')^{(7)}-(a_i'')^{(7)}(T_{37}(s_{(36)}),s_{(36)})\}ds_{(36)}\right]}\geq 0$ $T_i\ (t)\geq T_i^0 e^{\left(-(b_i')^{(7)}t\right)}>0\ \ \text{for } \mathrm{t}>0$	261
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Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(7)}((G_{39})(t),t)) = (b_{37}')^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i'')^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$	264
Then $\frac{dT_{37}}{dt} \geq (a_{37})^{(7)}(m)^{(7)} - \varepsilon_7 T_{37}$ which leads to $T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{\varepsilon_7}\right)(1-e^{-\varepsilon_7 t}) + T_{37}^0 e^{-\varepsilon_7 t}$ If we take t such that $e^{-\varepsilon_7 t} = \frac{1}{2}$ it results $T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{2}\right), \quad t = log\frac{2}{\varepsilon_7}$ By taking now ε_7 sufficiently small one sees that T_{37} is unbounded. The same property holds for T_{38} if $\lim_{t\to\infty}(b_{38}'')^{(7)}\left((G_{39})(t),t\right) = (b_{38}')^{(7)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	265
It is now sufficient to take $\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$ and to choose $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ large to have	266
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
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In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **Definition of** $\widetilde{(G_{43})}, \widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results	271

$\left\lvert\tilde{G}_{40}^{(1)}-\tilde{G}_{i}^{(2)}\right\rvert \le \int_0^t (a_{40})^{(8)} \left\lvert G_{41}^{(1)}-G_{41}^{(2)}\right\rvert e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}}\, ds_{(40)} +$ $\int_0^t \{(a_{40}')^{(8)} \left\lvert G_{40}^{(1)}-G_{40}^{(2)}\right\rvert e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} +$ $(a_{40}'')^{(8)}(T_{41}^{(1)},s_{(40)}) \left\lvert G_{40}^{(1)}-G_{40}^{(2)}\right\rvert e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} +$ $G_{40}^{(2)} \lvert (a_{40}'')^{(8)}(T_{41}^{(1)},s_{(40)}) - (a_{40}'')^{(8)}(T_{41}^{(2)},s_{(40)}) \rvert \; e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} \} ds_{(40)}$	
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If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$	278
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
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$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right) = \sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})}, \widetilde{(T_{47})} : \left(\widetilde{(G_{47})}, \widetilde{(T_{47})}\right) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$
$\int_0^t \{(a_{44}')^{(9)} |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)} |(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a_{44}'')^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$|(G_{47})^{(1)} - G^{(2)}| e^{-(\widehat{M}_{44})^{(9)} t} \leq$
$\frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)} \right) d \left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)} \right) \right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)} \right]} \geq 0$

$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$

Definition of $\left((\widehat{M}_{44})^{(9)} \right)_1, \left((\widehat{M}_{44})^{(9)} \right)_2$ *and* $\left((\widehat{M}_{44})^{(9)} \right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)} \right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)} \right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)} \right)_1 / (a_{45}')^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)} \right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)} \right)_2 / (a_{46}')^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t),t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t),t) = (b_{46}^{'})^{(9)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying

$$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14},t) + (a_{14}^{''})^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$$

$$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$$

Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: 281

By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: 282

By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- 283

If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by

$$(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \; if \; (\nu_0)^{(1)} < (\nu_1)^{(1)}$$

$$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \; (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$$

and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}\ , if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \le -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \le -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \le -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}((G_{19}), t) - (b_{17}^{''})^{(2)}((G_{19}), t) \le -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}(u^{(2)})^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}(u^{(2)})^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}, \ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq$ $\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}] + G_{18}^0 e^{-(a_{18}')^{(2)}t})$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
Definition of $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}\ ,\boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ ,\boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})}\left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)} - (b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)})}\left[e^{((R_1)^{(3)} + (r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \le -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \le -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \le -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \le -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)}, \; \boldsymbol{if} \; (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}, \boldsymbol{if} \; (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)}, \; \boldsymbol{if} \; (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)}, \; \boldsymbol{if} \; (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}, \boldsymbol{if} \; (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \textbf{\textit{if}}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>**Definition of**</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>**Definition of**</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}\ , \boldsymbol{if}\ (\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \le G_{28}(t) \le G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \le G_{29}(t) \le \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \le G_{30}(t) \le\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b'_{30})^{(5)}t}\right]+T_{30}^0 e^{-(b'_{30})^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)},(S_2)^{(5)},(R_1)^{(5)},(R_2)^{(5)}$:- Where $(S_1)^{(5)}=(a_{28})^{(5)}(m_2)^{(5)}-(a'_{28})^{(5)}$ $(S_2)^{(5)}=(a_{30})^{(5)}-(p_{30})^{(5)}$ $(R_1)^{(5)}=(b_{28})^{(5)}(\mu_2)^{(5)}-(b'_{28})^{(5)}$ $(R_2)^{(5)}=(b'_{30})^{(5)}-(r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$: $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)}\leq-(a'_{32})^{(6)}+(a'_{33})^{(6)}-(a''_{32})^{(6)}(T_{33},t)+(a''_{33})^{(6)}(T_{33},t)\leq-(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)}\leq-(b'_{32})^{(6)}+(b'_{33})^{(6)}-(b''_{32})^{(6)}((G_{35}),t)-(b''_{33})^{(6)}((G_{35}),t)\leq-(\tau_1)^{(6)}$	349
Definition of $(\nu_1)^{(6)},(\nu_2)^{(6)},(u_1)^{(6)},(u_2)^{(6)},\nu^{(6)},u^{(6)}$: By $(\nu_1)^{(6)}>0,(\nu_2)^{(6)}<0$ and respectively $(u_1)^{(6)}>0,(u_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_1)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},$ ***if*** $(\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},$ ***if*** $(\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)},$ and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},$ ***if*** $(\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \le -(a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} - (a_{36}^{''})^{(7)}(T_{37}, t) + (a_{37}^{''})^{(7)}(T_{37}, t) \le -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \le -(b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (b_{36}^{''})^{(7)}\big((G_{39}), t\big) - (b_{37}^{''})^{(7)}\big((G_{39}), t\big) \le -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \; \boldsymbol{if} \; (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if} \; (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \; \boldsymbol{if} \; (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if} \; (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if} \; (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \le G_{36}(t) \le G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})} \left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t} \right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}^{'})^{(7)})} [e^{(S_1)^{(7)}t} - e^{-(a_{38}^{'})^{(7)}t}] + G_{38}^0 e^{-(a_{38}^{'})^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}^{'})^{(7)})} \left[e^{(R_1)^{(7)}t} - e^{-(b_{38}^{'})^{(7)}t} \right] + T_{38}^0 e^{-(b_{38}^{'})^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})} \left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t} \right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}^{'})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)}$ $(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} - (a_{40}^{''})^{(8)}(T_{41}, t) + (a_{41}^{''})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43}), t) - (b_{41}^{''})^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}(\nu^{(8)})^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},$ ***if*** $(\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},$ ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},$ ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)},$ ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}\left((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)}\right)}\left[e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}\left((S_1)^{(8)} - (a_{42}')^{(8)}\right)}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)}T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)}T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45},t) + (a''_{45})^{(9)}(T_{45},t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}((G_{47}),t) - (b''_{45})^{(9)}((G_{47}),t) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \; \boldsymbol{if} \; (\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, ***if*** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$, and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, ***if*** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$	
and analogously $(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, ***if*** $(u_0)^{(9)} < (u_1)^{(9)}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, ***if*** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$, and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, ***if*** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively	
Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	
($\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$ $\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t}$)	
$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t}\right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$ $\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$	

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$	
Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \le \frac{d\nu^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \ge \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \le \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \le \nu^{(1)}(t) \le$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \le (\bar{\nu}_1)^{(1)} \le \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \le \nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\nu_0)^{(1)}$	386

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
<u>**Definition of**</u> $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain <u>**Definition of**</u> $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
<u>**Particular case :**</u> If $(a_{16}'')^{(2)} = (a_{17}'')^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b_{16}'')^{(2)} = (b_{17}'')^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)}$, $\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)}$, $\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

<u>Proof</u> : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

<u>Definition of</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

<u>Definition of</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}$, $\boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .** Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.	
<u>**Proof**</u> : From 99,20,44,22,23,44 we obtain $$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get	

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-(b_{28}^{'})^{(5)}(r_{29})^{(5)}-(b_{29}^{'})^{(5)}(r_{29})^{(5)}+(r_{28})^{(5)}(r_{29})^{(5)}<0$ $with\ (p_{28})^{(5)},(r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}<0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}+(a_{32})^{(6)}(p_{32})^{(6)}+(a_{33}^{'})^{(6)}(p_{33})^{(6)}+(p_{32})^{(6)}(p_{33})^{(6)}>0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}>0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-(b_{32}^{'})^{(6)}(r_{33})^{(6)}-(b_{33}^{'})^{(6)}(r_{33})^{(6)}+(r_{32})^{(6)}(r_{33})^{(6)}<0$ $with\ (p_{32})^{(6)},(r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)}-(a_{36})^{(7)}(a_{37})^{(7)}<0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)}-(a_{36})^{(7)}(a_{37})^{(7)}+(a_{36})^{(7)}(p_{36})^{(7)}+(a_{37}^{'})^{(7)}(p_{37})^{(7)}+(p_{36})^{(7)}(p_{37})^{(7)}>0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}>0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-(b_{36}^{'})^{(7)}(r_{37})^{(7)}-(b_{37}^{'})^{(7)}(r_{37})^{(7)}+(r_{36})^{(7)}(r_{37})^{(7)}<0$ $with\ (p_{36})^{(7)},(r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)}-(a_{40})^{(8)}(a_{41})^{(8)}<0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)}-(a_{40})^{(8)}(a_{41})^{(8)}+(a_{40})^{(8)}(p_{40})^{(8)}+(a_{41}^{'})^{(8)}(p_{41})^{(8)}+(p_{40})^{(8)}(p_{41})^{(8)}>0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)}-(b_{40})^{(8)}(b_{41})^{(8)}>0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)}-(b_{40})^{(8)}(b_{41})^{(8)}-(b_{40}^{'})^{(8)}(r_{41})^{(8)}-(b_{41}^{'})^{(8)}(r_{41})^{(8)}+(r_{40})^{(8)}(r_{41})^{(8)}<0$ $with\ (p_{40})^{(8)},(r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)}-(a_{44})^{(9)}(a_{45})^{(9)}<0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)}-(a_{44})^{(9)}(a_{45})^{(9)}+(a_{44})^{(9)}(p_{44})^{(9)}+(a_{45}^{'})^{(9)}(p_{45})^{(9)}+(p_{44})^{(9)}(p_{45})^{(9)}>0$	436 A

$(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}>0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}-(b_{44}^{'})^{(9)}(r_{45})^{(9)}-(b_{45}^{'})^{(9)}(r_{45})^{(9)}+(r_{44})^{(9)}(r_{45})^{(9)}<0$ $with\ (p_{44})^{(9)},(r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14}-\left[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14})\right]G_{13}=0$	437
$(a_{14})^{(1)}G_{13}-\left[(a_{14}^{'})^{(1)}+(a_{14}^{''})^{(1)}(T_{14})\right]G_{14}=0$	438
$(a_{15})^{(1)}G_{14}-\left[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14})\right]G_{15}=0$	439
$(b_{13})^{(1)}T_{14}-[(b_{13}^{'})^{(1)}-(b_{13}^{''})^{(1)}(G)]T_{13}=0$	440
$(b_{14})^{(1)}T_{13}-[(b_{14}^{'})^{(1)}-(b_{14}^{''})^{(1)}(G)]T_{14}=0$	441
$(b_{15})^{(1)}T_{14}-[(b_{15}^{'})^{(1)}-(b_{15}^{''})^{(1)}(G)]T_{15}=0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17}-\left[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17})\right]G_{16}=0$	443
$(a_{17})^{(2)}G_{16}-\left[(a_{17}^{'})^{(2)}+(a_{17}^{''})^{(2)}(T_{17})\right]G_{17}=0$	444
$(a_{18})^{(2)}G_{17}-\left[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17})\right]G_{18}=0$	445
$(b_{16})^{(2)}T_{17}-[(b_{16}^{'})^{(2)}-(b_{16}^{''})^{(2)}(G_{19})]T_{16}=0$	446
$(b_{17})^{(2)}T_{16}-[(b_{17}^{'})^{(2)}-(b_{17}^{''})^{(2)}(G_{19})]T_{17}=0$	447
$(b_{18})^{(2)}T_{17}-[(b_{18}^{'})^{(2)}-(b_{18}^{''})^{(2)}(G_{19})]T_{18}=0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21}-\left[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21})\right]G_{20}=0$	449
$(a_{21})^{(3)}G_{20}-\left[(a_{21}^{'})^{(3)}+(a_{21}^{''})^{(3)}(T_{21})\right]G_{21}=0$	450
$(a_{22})^{(3)}G_{21}-\left[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21})\right]G_{22}=0$	451
$(b_{20})^{(3)}T_{21}-[(b_{20}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23})]T_{20}=0$	452
$(b_{21})^{(3)}T_{20}-[(b_{21}^{'})^{(3)}-(b_{21}^{''})^{(3)}(G_{23})]T_{21}=0$	453
$(b_{22})^{(3)}T_{21}-[(b_{22}^{'})^{(3)}-(b_{22}^{''})^{(3)}(G_{23})]T_{22}=0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25}-\left[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25})\right]G_{24}=0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\,]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (aa) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T^*_{17} for which $f(T^*_{17}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	495
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Definition and uniqueness of T^*_{25} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T^*_{25} for which $f(T^*_{25}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a'_{24})^{(4)}+(a''_{24})^{(4)}(T^*_{25})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a'_{26})^{(4)}+(a''_{26})^{(4)}(T^*_{25})]}$	497
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Definition and uniqueness of T^*_{33} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T^*_{33} for which $f(T^*_{33}) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
<u>Definition and uniqueness of</u> T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
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Where in $(G_{19})(G_{16},G_{17},G_{18}), G_{16},G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23})=(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23})+(b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20},G_{21},G_{22}), G_{20},G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
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By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b_{40}')^{(8)}(b_{41}'')^{(8)}(G_{43}) + (b_{41}')^{(8)}(b_{40}'')^{(8)}(G_{43})\right] + (b_{40}'')^{(8)}(G_{43})(b_{41}'')^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
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Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial \mathbb{T}_{17}} (T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j} ((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)} G_{17}^* \mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)} G_{18}^* \mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)} T_{16}^* \mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)} T_{17}^* \mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)} T_{18}^* \mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}} (T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j} ((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)} G_{20}^* \mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)} G_{21}^* \mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)} G_{22}^* \mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	547
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 5:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	555
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}(\,(G_{31})^{*}\,) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*}) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}\left((G_{35})^{*}\right) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{37})^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b''_i)^{(7)}}{\partial G_j} \left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a'_{36})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G_{36}^* \mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a'_{37})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G_{37}^* \mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G_{38}^* \mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T_{36}^* \mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T_{37}^* \mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T_{38}^* \mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}} (T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b''_i)^{(8)}}{\partial G_j} \left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G_{40}^* \mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G_{41}^* \mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof: Denote**	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial(b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$+\left(\left((\lambda)^{(1)}+(a'_{14})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G^*_{13}+(a_{13})^{(1)}(q_{14})^{(1)}G^*_{14}\right)$

$\left(\left((\lambda)^{(1)}+(b'_{13})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T^*_{14}+(b_{14})^{(1)}s_{(13),(13)}T^*_{13}\right)$

$\left(\left((\lambda)^{(1)}\right)^2+\left((a'_{13})^{(1)}+(a'_{14})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^2+\left((b'_{13})^{(1)}+(b'_{14})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^2+\left((a'_{13})^{(1)}+(a'_{14})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$

$+\left((\lambda)^{(1)}+(a'_{13})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G^*_{14}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G^*_{13}\right)$

$\left(\left((\lambda)^{(1)}+(b'_{13})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T^*_{14}+(b_{14})^{(1)}s_{(13),(15)}T^*_{13}\right)\}=0$

$+$

$\left((\lambda)^{(2)}+(b'_{18})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a'_{18})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a'_{16})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}G^*_{17}+(a_{17})^{(2)}(q_{16})^{(2)}G^*_{16}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b'_{16})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}T^*_{17}+(b_{17})^{(2)}s_{(16),(17)}T^*_{17}\right)$

$+\left(\left((\lambda)^{(2)}+(a'_{17})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}G^*_{16}+(a_{16})^{(2)}(q_{17})^{(2)}G^*_{17}\right)$

$\left(\left((\lambda)^{(2)}+(b'_{16})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}T^*_{17}+(b_{17})^{(2)}s_{(16),(16)}T^*_{16}\right)$

$\left(\left((\lambda)^{(2)}\right)^2+\left((a'_{16})^{(2)}+(a'_{17})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^2+\left((b'_{16})^{(2)}+(b'_{17})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^2+\left((a'_{16})^{(2)}+(a'_{17})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}G_{18}$

$+\left((\lambda)^{(2)}+(a'_{16})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}G^*_{17}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G^*_{16}\right)$

$\left(\left((\lambda)^{(2)}+(b'_{16})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}T^*_{17}+(b_{17})^{(2)}s_{(16),(18)}T^*_{16}\right)\}=0$

$+$

$\left((\lambda)^{(3)}+(b'_{22})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a'_{22})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a'_{20})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G^*_{21}+(a_{21})^{(3)}(q_{20})^{(3)}G^*_{20}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b'_{20})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T^*_{21}+(b_{21})^{(3)}s_{(20),(21)}T^*_{21}\right)$

$+\Big(\big((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\big)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\Big)$ $\Big(\big((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\big)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\Big)$ $\Big(\big((\lambda)^{(3)}\big)^2+\big((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\big)(\lambda)^{(3)}\Big)$ $\Big(\big((\lambda)^{(3)}\big)^2+\big((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\big)(\lambda)^{(3)}\Big)$ $+\Big(\big((\lambda)^{(3)}\big)^2+\big((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\big)(\lambda)^{(3)}\Big)(q_{22})^{(3)}G_{22}$ $+\big((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\big)\big((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\big)$ $\Big(\big((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\big)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\Big)\}=0$ +	
$\big((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)}\big)\{\big((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)}\big)$ $\Big[\Big(\big((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\big)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\Big)\Big]$ $\Big(\big((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\big)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\Big)$ $+\Big(\big((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\big)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\Big)$ $\Big(\big((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\big)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\Big)$ $\Big(\big((\lambda)^{(4)}\big)^2+\big((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\big)(\lambda)^{(4)}\Big)$ $\Big(\big((\lambda)^{(4)}\big)^2+\big((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\big)(\lambda)^{(4)}\Big)$ $+\Big(\big((\lambda)^{(4)}\big)^2+\big((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\big)(\lambda)^{(4)}\Big)(q_{26})^{(4)}G_{26}$ $+\big((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\big)\big((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\big)$ $\Big(\big((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\big)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\Big)\}=0$ +	
$\big((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)}\big)\{\big((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)}\big)$ $\Big[\Big(\big((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\big)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\Big)\Big]$ $\Big(\big((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\big)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\Big)$	

$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$

$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$

$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$

$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$

$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$

$+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$

$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$

+

$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$

$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$

$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$

$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$

$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$

$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$

$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$

+

$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$

$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$

$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$

$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)$

$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)$

$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)}+(a_{45}')^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION TWENTY EIGHT

Holographic Description Of A Quantum Black Hole On A Computer

INTRODUCTION—VARIABLES USED

Communications in Mathematical Physics November 2006, Volume 267, Issue 3, pp 783-800 First online: 17 August 2006 Moduli Space of BPS Walls in Supersymmetric Gauge Theories Norisuke Sakai , Yisong Yang

(1) The proof is extended to the U (N C) gauge theory with (e&eb) N F hypermultiplets in the fundamental representation, provided (e) the moduli matrix of the domain wall solution is (=) U (1)-factorizable.
(2) Thus the dimension of the moduli space of U (N C) gauge theory is bounded from (e) below by (e) the dimension of the U (1)-factorizable part of the moduli space.
(3) They also obtain sharp estimates of the asymptotic exponential decay which depend on (=) both the gauge coupling and the hypermultiplet mass differences. Communicated by N.A. Nekrasov

(Separate models given)

Holographic description of a quantum black hole on a computer Masanori Hanada1, 2, 3,*, Yoshifumi Hyakutake4, Goro Ishiki1, Jun Nishimura5,6 Science 23 May 2014: Vol. 344, Issue 6186, pp. 882-885 DOI: 10.1126/science.1250122

- **(4)** Black holes have been predicted to radiate particles and eventually evaporate (e&eb) which has led to (eb) the information loss paradox and implies (eb) that the fundamental laws of quantum mechanics may be (=) violated.
- **(5)** Superstring theory, a consistent theory of quantum gravity, provides (eb) a possible solution to the paradox if (e) evaporating black holes can actually be described in terms of (e&eb) standard quantum mechanical systems, as conjectured from (e) the theory.
- **(6)** Here, authors test this conjecture by calculating the mass of a black hole in (e&eb) the corresponding quantum mechanical system numerically.
- **(7)** Results agree well with (eb) the prediction from gravity theory, including (e) the leading quantum gravity correction.
- **(8)** Ability to simulate (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics.
- **(9)** Quantum mechanics and (e&eb) gravity can seem to contradict each other.
- **(10)** Superstring theory may provide (eb) a route to reconcile the two, thanks to (e) the gauge/gravity duality conjecture, which allows (eb) the system to be described mathematically.
- **(11)** However, this conjecture has yet to be formally confirmed. Hanada et al. (see the Perspective by Maldacena) performed a simulation of (e&eb) the dual gauge theory in the parameter regime that corresponds to (e&eb) a quantum black hole.
- **(12)** Their results agree with (eb) a prediction for an evaporating black hole, including (e) quantum gravity corrections, confirming that (eb) the dual gauge theory indeed provides (eb) a complete description of the quantum nature of (e) the evaporating black hole. Science, this issue p. 882; see also p. 806

NOTATION

Module One

Therefore the moduli space at finite gauge couplings is topologically the same manifold as that at infinite gauge coupling, where (e) the gauged linear sigma model reduces to (e&eb) a nonlinear sigma model

G_{13} : Category one of gauged linear sigma model reduces to (e&eb) a nonlinear sigma model

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of moduli space at finite gauge couplings is topologically the same manifold as that at infinite gauge coupling

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Therefore the moduli space at finite gauge couplings is topologically the same manifold as that at infinite gauge coupling, where the gauged linear sigma model reduces to (e&eb) a nonlinear sigma model

G_{16} : Category one of **moduli space at finite gauge couplings is topologically the same manifold as that at infinite gauge coupling, where the gauged linear sigma model;** nonlinear sigma model G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of nonlinear sigma model; **moduli space at finite gauge couplings is topologically the same manifold as that at infinite gauge coupling, where the gauged linear sigma model** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three The proof is extended to the U (N C) gauge theory with (e&eb) N F hypermultiplets in the fundamental representation, provided (e) the moduli matrix of the domain wall solution is (=) U (1)-factorizable	
G_{20} : Category one of **proof is extended to the U (N C) gauge theory;** N F hypermultiplets in the fundamental representation, provided (e) the moduli matrix of the domain wall solution is (=) U (1)-factorizable G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of N F hypermultiplets in the fundamental representation, provided (e) the moduli matrix of the domain wall solution is (=) U (1)-factorizable; **proof is extended to the U (N C) gauge theory** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four The proof is extended to the U (N C) gauge theory with (e&eb) N F hypermultiplets in the fundamental representation, provided the moduli matrix of the domain wall solution is (=) U (1)-factorizable	
G_{24} : Category one of proof is extended to the U (N C) gauge theory with (e&eb) N F hypermultiplets in the fundamental representation, provided the moduli matrix of the domain wall solution G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of U (1)-factorizable T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Thus the dimension of the moduli space of U (N C) gauge theory is bounded from (e) **below by the dimension of the U (1)-factorizable part of the moduli space**	

G_{28} : Category one of dimension of the moduli space of U (N C) gauge theory is bounded; **below by the dimension of the U (1)-factorizable part of the moduli space** G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of **below by the dimension of the U (1)-factorizable part of the moduli space** ;dimension of the moduli space of U (N C) gauge theory is bounded T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six They also obtain sharp estimates of the asymptotic exponential decay which depend on (=) both the gauge coupling and the hypermultiplet mass differences. Communicated by N.A. Nekrasov (Separate models given)	
G_{32} : Category one of **sharp estimates of the asymptotic exponential decay;** gauge coupling G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of gauge coupling; **sharp estimates of the asymptotic exponential decay** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven They also obtain sharp estimates of the asymptotic exponential decay which depend on (=) both the gauge coupling and the hypermultiplet mass differences. Communicated by N.A. Nekrasov (Separate models given)	
G_{36} : Category one of **sharp estimates of the asymptotic exponential decay;** hypermultiplet mass differences G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of hypermultiplet mass differences; **sharp estimates of the asymptotic exponential decay** T_{37} : Category two of SAS	

T_{38} : Category three of SAS	
Module eight Black holes have been predicted to radiate particles and eventually evaporate (e&eb) which has led to (eb) the information loss paradox and implies (eb) that the fundamental laws of quantum mechanics may be (=) violated	
G_{40} : Category one of **Black holes have been predicted to radiate particles and eventually evaporate;** information loss paradox and implies (eb) that the fundamental laws of quantum mechanics may be (=) violated G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of information loss paradox and implies (eb) that the fundamental laws of quantum mechanics may be (=) violated **;Black holes have been predicted to radiate particles and eventually evaporate** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine Black holes have been predicted to radiate particles and eventually evaporate which has led to (eb) the information loss paradox and implies (eb) that the fundamental laws of quantum mechanics may be (=) violated	
G_{44} : Category one of Black holes have been predicted to radiate particles and eventually evaporate G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of information loss paradox and implies (eb) that the fundamental laws of quantum mechanics may be (=) violated T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$	

$(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}, (b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$ $, (a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}\ (a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)},$ $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)},$ $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)},$ are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t) \right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}, t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}, t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}, t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}), t\right) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}), t\right) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}), t\right) \right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}), t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21}, t) \right] G_{20}$	13

$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)} (T_{21}, t) \right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)} (T_{21}, t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)} (G_{23}, t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)} (G_{23}, t) \right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)} (G_{23}, t) \right] T_{22}$	18
$+(a_{20}^{''})^{(3)} (T_{21}, t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)} (G_{23}, t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)} (T_{25}, t) \right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)} (T_{25}, t) \right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)} (T_{25}, t) \right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)} \left((G_{27}), t \right) \right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)} \left((G_{27}), t \right) \right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)} \left((G_{27}), t \right) \right] T_{26}$	24
$+(a_{24}^{''})^{(4)} (T_{25}, t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)} \left((G_{27}), t \right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)} (T_{29}, t) \right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}, t) \right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}, t) \right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} \left((G_{31}), t \right) \right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} \left((G_{31}), t \right) \right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} \left((G_{31}), t \right) \right] T_{30}$	30
$+(a_{28}^{''})^{(5)} (T_{29}, t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)} \left((G_{31}), t \right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)} (T_{33}, t) \right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}, t) \right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}, t) \right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} \left((G_{35}), t \right) \right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} \left((G_{35}), t \right) \right] T_{33}$	35

$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	*42*
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right]G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41},t)\right]G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*55*

$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	60
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for	

category 1, 2 and 3 $-(b''_{20})^{(3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{37})^{(7,7,)}(G_{39},t)$, $-(b''_{36})^{(7,7,)}(G_{39},t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8)}(G_{43},t)$ $-(b''_{41})^{(8,8)}(G_{43},t)$ $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[\begin{matrix}(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17},t)+(a''_{13})^{(1,1,)}(T_{14},t)+(a''_{20})^{(3,3,3)}(T_{21},t)\\+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)\\+(a''_{36})^{(7,7,7)}(T_{37},t)+(a''_{40})^{(8,8,8)}(T_{41},t)+(a''_{44})^{(9,9)}(T_{45},t)\end{matrix}\right]G_{16}$	*61*
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[\begin{matrix}(a'_{17})^{(2)}+(a''_{17})^{(2)}(T_{17},t)+(a''_{14})^{(1,1,)}(T_{14},t)+(a''_{21})^{(3,3,3)}(T_{21},t)\\+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)\\+(a''_{37})^{(7,7,7)}(T_{37},t)+(a''_{41})^{(8,8,8)}(T_{41},t)+(a''_{45})^{(9,9)}(T_{45},t)\end{matrix}\right]G_{17}$	*62*
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[\begin{matrix}(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17},t)+(a''_{15})^{(1,1,)}(T_{14},t)+(a''_{22})^{(3,3,3)}(T_{21},t)\\+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)\\+(a''_{38})^{(7,7,7)}(T_{37},t)+(a''_{42})^{(8,8,8)}(T_{41},t)+(a''_{46})^{(9,9)}(T_{45},t)\end{matrix}\right]G_{18}$	*63*
Where $+(a''_{16})^{(2)}(T_{17},t)$, $+(a''_{17})^{(2)}(T_{17},t)$, $+(a''_{18})^{(2)}(T_{17},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,)}(T_{14},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	*64*
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$	*65*
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	*66*
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$	*67*

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a_{21}^{'})^{(3)} \boxed{+(a_{21}^{''})^{(3)}(T_{21},t)} \boxed{+(a_{17}^{''})^{(2,2,2)}(T_{17},t)} \boxed{+(a_{14}^{''})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21} \quad 68$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a_{22}^{'})^{(3)} \boxed{+(a_{22}^{''})^{(3)}(T_{21},t)} \boxed{+(a_{18}^{''})^{(2,2,2)}(T_{17},t)} \boxed{+(a_{15}^{''})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22} \quad 69$$

$\boxed{+(a_{20}^{''})^{(3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}^{''})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{13}^{''})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{36}^{''})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}^{''})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}^{''})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{40}^{''})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{44}^{''})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b_{20}^{'})^{(3)} \boxed{-(b_{20}^{''})^{(3)}(G_{23},t)} \boxed{-(b_{16}^{''})^{(2,2,2)}(G_{19},t)} \boxed{-(b_{13}^{''})^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}^{''})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}^{''})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b_{21}^{'})^{(3)} \boxed{-(b_{21}^{''})^{(3)}(G_{23},t)} \boxed{-(b_{17}^{''})^{(2,2,2)}(G_{19},t)} \boxed{-(b_{14}^{''})^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}^{''})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}^{''})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}^{''})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b_{22}^{'})^{(3)} \boxed{-(b_{22}^{''})^{(3)}(G_{23},t)} \boxed{-(b_{18}^{''})^{(2,2,2)}(G_{19},t)} \boxed{-(b_{15}^{''})^{(1,1,1,)}(G,t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{38}^{''})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}^{''})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22} \quad 72$$

$\boxed{-(b_{20}^{''})^{(3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{16}^{''})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for*

category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$

are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$

are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\begin{bmatrix}(b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{24} \quad 76$$

$$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\begin{bmatrix}(b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{25} \quad 77$$

$$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\begin{bmatrix}(b'_{26})^{(4)}\boxed{-(b''_{26})^{(4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\begin{bmatrix}(a'_{28})^{(5)}\boxed{+(a''_{28})^{(5)}(T_{29},t)}\ \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}\ \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}\ \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}\ \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}\ \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}\ \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{28} \quad 79$$

$$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\left[\begin{array}{c}(a'_{29})^{(5)}\boxed{+(a''_{29})^{(5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}\end{array}\right]G_{29}$$ 80

$$\frac{dG_{30}}{dt}=(a_{30})^{(5)}G_{29}-\left[\begin{array}{c}(a'_{30})^{(5)}\boxed{+(a''_{30})^{(5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}\end{array}\right]G_{30}$$ 81

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8\,,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[\begin{array}{c}(b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}\end{array}\right]T_{28}$$ 82

$$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[\begin{array}{c}(b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}\end{array}\right]T_{29}$$ 83

$$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[\begin{array}{c}(b'_{30})^{(5)}\boxed{-(b''_{30})^{(5)}(G_{31},t)}\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}\end{array}\right]T_{30}$$ 84

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients*

$for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{32}$	85
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{33}$	86
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{34}$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ $are\ first\ augmentation\ coefficients$ $for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ $are\ second\ augmentation$ $coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ $are\ third\ augmentation$ $coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients	

$+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)$ seventh augmentation coefficients $+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)$ Eighth augmentation coefficients $+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} -(b''_{32})^{(6)}(G_{35},t) -(b''_{28})^{(5,5,5)}(G_{31},t) -(b''_{24})^{(4,4,4,)}(G_{27},t) \\ -(b''_{13})^{(1,1,1,1,1,1)}(G,t) -(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t) -(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t) -(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{32}$	*88*
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} -(b''_{33})^{(6)}(G_{35},t) -(b''_{29})^{(5,5,5)}(G_{31},t) -(b''_{25})^{(4,4,4,)}(G_{27},t) \\ -(b''_{14})^{(1,1,1,1,1,1)}(G,t) -(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t) -(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t) -(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t) -(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{33}$	*89*
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} -(b''_{34})^{(6)}(G_{35},t) -(b''_{30})^{(5,5,5)}(G_{31},t) -(b''_{26})^{(4,4,4,)}(G_{27},t) \\ -(b''_{15})^{(1,1,1,1,1,1)}(G,t) -(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t) -(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t) -(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t) -(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{34}$	*90*
$-(b''_{32})^{(6)}(G_{35},t)$, $-(b''_{33})^{(6)}(G_{35},t)$, $-(b''_{34})^{(6)}(G_{35},t)$ *are first detrition coefficients for category* 1, 2 *and* 3 $-(b''_{28})^{(5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5)}(G_{31},t)$ *are second detrition coefficients for category* 1, 2 *and* 3 $-(b''_{24})^{(4,4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,)}(G_{27},t)$ *are third detrition coefficients for category* 1,2 *and* 3 $-(b''_{13})^{(1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1)}(G,t)$, $-(b''_{15})^{(1,1,1,1,1,1)}(G,t)$ are fourth detrition coefficients for category 1, 2, and 3 $-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)$ are fifth detrition coefficients for category 1, 2, and 3 $-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)$ are sixth detrition coefficients for category 1, 2, and 3 $-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2, and 3 $-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2, and 3 $-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2, and 3	

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[\begin{matrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$$

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$$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[\begin{matrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$$

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$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[\begin{matrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$$

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Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$

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$$\frac{dT_{37}}{dt} =$$

$$(b_{37})^{(7)}T_{36} - \begin{bmatrix} (b_{37}')^{(7)} \boxed{-(b_{37}'')^{(7)}(G_{39},t)} \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} =$$

$$(b_{38})^{(7)}T_{37} - \begin{bmatrix} (b_{38}')^{(7)} \boxed{-(b_{38}'')^{(7)}(G_{39},t)} \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b_{36}'')^{(7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a_{40}')^{(8)} \boxed{+(a_{40}'')^{(8)}(T_{41},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 95$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$(b_{41})^{(8)}T_{40}-\begin{bmatrix}(b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{14}$	
$\frac{dT_{42}}{dt}=$ $(b_{42})^{(8)}T_{41}-\begin{bmatrix}(b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt}=(a_{44})^{(9)}G_{45}-\begin{bmatrix}(a'_{44})^{(9)}\boxed{+(a''_{44})^{(9)}(T_{45},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}\end{bmatrix}G_{13}$	96
$\frac{dG_{45}}{dt}=(a_{45})^{(9)}G_{44}-\begin{bmatrix}(a'_{45})^{(9)}\boxed{+(a''_{45})^{(9)}(T_{45},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}\end{bmatrix}G_{14}$	

$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$	
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{46}}{dt} =$	

$(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i^{''})^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i^{''})^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b_i^{'})^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2 \to \infty} (a_i^{''})^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b_i^{''})^{(1)} (G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\lvert(a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\rvert \le (\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and$(a_i'')^{(1)}(T_{14},t)$.(T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)}, (r_i)^{(1)}, i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i')^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i')^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0, \quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t)\le(p_i)^{(2)}\le\left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t)\le (r_i)^{(2)}\le(b_i')^{(2)}\le(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}\left((G_{19}),t\right)= (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i=16,17,18$	106
They satisfy Lipschitz condition:	

$\lvert(a_i^{''})^{(2)}(T_{17}^{'},t)-(a_i^{''})^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}^{'}\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i^{''})^{(2)}((G_{19})^{'},t)-(b_i^{''})^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})^{'}\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'},t)$ and $(a_i^{''})^{(2)}(T_{17},t)$. $(T_{17}^{'},t)$ and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i^{''})^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i^{'})^{(2)},(b_i)^{(2)},(b_i^{'})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)}+(a_i^{'})^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i^{'})^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i^{'})^{(3)},(a_i^{''})^{(3)},(b_i)^{(3)},(b_i^{'})^{(3)},(b_i^{''})^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i^{''})^{(3)},(b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)},\ (\mathrm{r_i})^{(3)}$: $(a_i^{''})^{(3)}(T_{21},t)\leq(p_i)^{(3)}\leq(\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23},t)\leq\ (r_i)^{(3)}\leq(b_i^{'})^{(3)}\leq(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i^{''})^{(3)}\,(T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i^{''})^{(3)}\,(G_{23},t)=\ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}}$ are positive constants and $\boxed{i=20,21,22}$	113

They satisfy Lipschitz condition: 114

$|(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)| \leq (\hat{k}_{20})^{(3)}|T_{21} - T_{21}'|e^{-(\hat{M}_{20})^{(3)}t}$

$|(b_i'')^{(3)}(G_{23}',t)-(b_i'')^{(3)}(G_{23},t)| < (\hat{k}_{20})^{(3)}||G_{23}-G_{23}'||e^{-(\hat{M}_{20})^{(3)}t}$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and$(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: 115

$(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants

$\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)}, (r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities 116

$\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)}+(a_i')^{(3)}+(\hat{A}_{20})^{(3)}+(\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$

$\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)}+(b_i')^{(3)}+(\hat{B}_{20})^{(3)}+(\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$

Where we suppose

$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)} > 0, \quad i,j=24,25,26$ 117

The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(4)}, (r_i)^{(4)}$:

$(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$

$(b_i'')^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$

$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ 118

$\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t)= (r_i)^{(4)}$

Definition of $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$:

Where $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)}, (r_i)^{(4)}$ are positive constants and $i=24,25,26$

They satisfy Lipschitz condition: 119

$\lvert(a_i'')^{(4)}(T_{25}',t)-(a_i'')^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i'')^{(4)}((G_{27})',t)-(b_i'')^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and$(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
Definition of $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(p_i)^{(4)},\ (r_i)^{(4)},i=24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (a_i)^{(4)}+(a_i')^{(4)}+\ (\hat{A}_{24})^{(4)}+\ (\hat{P}_{24})^{(4)}\ (\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)}+(b_i')^{(4)}+\ (\hat{B}_{24})^{(4)}+\ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i')^{(5)},(a_i'')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(b_i'')^{(5)}>0,\quad i,j=28,29,30$ The functions $(a_i'')^{(5)},(b_i'')^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)},\ (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t)\leq(p_i)^{(5)}\leq(\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}),t)\leq\ (r_i)^{(5)}\leq(b_i')^{(5)}\leq(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t)=\ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123

They satisfy Lipschitz condition: $\|(a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\| \leq (\hat{k}_{28})^{(5)}\|T_{29}-T_{29}'\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}((G_{31}),t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31})-(G_{31})'\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}$, $\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	125
Definition of $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(p_i)^{(5)}$, $(r_i)^{(5)}, i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)}+(a_i')^{(5)}+(\hat{A}_{28})^{(5)}+(\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)}+(b_i')^{(5)}+(\hat{B}_{28})^{(5)}+(\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)},(a_i')^{(6)},(a_i'')^{(6)},(b_i)^{(6)},(b_i')^{(6)},(b_i'')^{(6)} > 0, \quad i,j=32,33,34$ The functions $(a_i'')^{(6)},(b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}$, $(r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
$lim_{T_2\to\infty}(a_i'')^{(6)}(T_{33},t)=(p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}((G_{35}),t)=(r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$:	128

Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(6)}(T_{33}^{'},t) - (a_i^{''})^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}^{'} \rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i^{''})^{(6)}((G_{35})^{'},t) - (b_i^{''})^{(6)}\big((G_{35}),t\big)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert(G_{35}) - (G_{35})^{'}\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'},t)$ and $(a_i^{''})^{(6)}(T_{33},t)$. $(T_{33}^{'},t)$ and (T_{33},t) are points belonging to the interval $\big[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\big]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>**Definition of**</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i^{'})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i^{'})^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i^{'})^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(GGGGGGG) $(a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (HHHHHHH) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39},t) \leq \ (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(IIIIIII) $\lim_{T_2 \to \infty} \ (a_i^{''})^{(7)} \ (T_{37},t) = (p_i)^{(7)}$ *(JJJJJJJ)* $\lim_{G \to \infty} (b_i^{''})^{(7)} \big((G_{39}),t\big) = \ (r_i)^{(7)}$	132

<u>**Definition of**</u> $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$:

Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}$ are positive constants and $i = 36,37,38$

They satisfy Lipschitz condition: 133

$$|(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)| \leq (\hat{k}_{36})^{(7)} |T_{37} - T_{37}'| e^{-(\hat{M}_{36})^{(7)} t}$$

$$|(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}\big((G_{39}), t\big)| < (\hat{k}_{36})^{(7)} ||(G_{39}) - (G_{39})'|| e^{-(\hat{M}_{36})^{(7)} t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $\big[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\big]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

<u>**Definition of**</u> $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: 134

(KKKKKKK) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants

$$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$$

<u>**Definition of**</u> $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: 135

(LLLLLLL) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and \ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{36})^{(7)}} [\, (a_i)^{(7)} + (a_i')^{(7)} + \ (\hat{A}_{36})^{(7)} + \ (\hat{P}_{36})^{(7)} \ (\hat{k}_{36})^{(7)}] < 1$$

$$\frac{1}{(\hat{M}_{36})^{(7)}} [\ (b_i)^{(7)} + (b_i')^{(7)} + \ (\hat{B}_{36})^{(7)} + \ (\hat{Q}_{36})^{(7)} \ \ (\hat{k}_{36})^{(7)}] < 1$$

Where we suppose

$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i, j = 40,41,42$ 136

The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded

<u>**Definition of**</u> $(p_i)^{(8)}, \ (r_i)^{(8)}$: 137

$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$ 138

$(b_i'')^{(8)}((G_{43}),t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i'')^{(8)}(T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i'')^{(8)}\left((G_{43}),t\right) = (r_i)^{(8)}$	141
<u>Definition of</u> $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t) - (a_i'')^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}\left((G_{43}),t\right)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
<u>Definition of</u> $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i')^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i')^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$$(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$$

$$(b_i^{''})^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$$

$$\lim_{T_2\to\infty} (a_i^{''})^{(9)}(T_{45},t) = (p_i)^{(9)}$$

$$\lim_{G\to\infty} (b_i^{''})^{(9)}(G_{47},t) = (r_i)^{(9)}$$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$$|(a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}^{'}|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})^{'}||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)} + (a_i^{'})^{(9)} + \ (\hat{A}_{44})^{(9)} + \ (\hat{P}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)} + (b_i^{'})^{(9)} + \ (\hat{B}_{44})^{(9)} + \ (\hat{Q}_{44})^{(9)}\ \ (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13}\right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$:	153

$G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}')^{(1)} - (b_{13}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}')^{(1)} - (b_{14}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}')^{(1)} - (b_{15}'')^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i\colon \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \le (\,\hat{P}_{16}\,)^{(2)}\,, T_i^0 \le (\,\hat{Q}_{16}\,)^{(2)},$	
$0 \le G_i(t) - G_i^0 \le (\,\hat{P}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)} t}$	
$0 \le T_i(t) - T_i^0 \le (\,\hat{Q}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}\big(s_{(16)}\big) - \Big((a_{16}')^{(2)} + a_{16}'')^{(2)}\big(T_{17}\big(s_{(16)}\big), s_{(16)}\big)\Big) G_{16}\big(s_{(16)}\big)\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}\big(s_{(16)}\big) - \Big((a_{17}')^{(2)} + (a_{17}'')^{(2)}\big(T_{17}\big(s_{(16)}\big), s_{(17)}\big)\Big) G_{17}\big(s_{(16)}\big)\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}\big(s_{(16)}\big) - \Big((a_{18}')^{(2)} + (a_{18}'')^{(2)}\big(T_{17}\big(s_{(16)}\big), s_{(16)}\big)\Big) G_{18}\big(s_{(16)}\big)\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}\big(s_{(16)}\big) - \Big((b_{16}')^{(2)} - (b_{16}'')^{(2)}\big(G_{19}\big(s_{(16)}\big), s_{(16)}\big)\Big) T_{16}\big(s_{(16)}\big)\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}\big(s_{(16)}\big) - \Big((b_{17}')^{(2)} - (b_{17}'')^{(2)}\big(G_{19}\big(s_{(16)}\big), s_{(16)}\big)\Big) T_{17}\big(s_{(16)}\big)\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}\big(s_{(16)}\big) - \Big((b_{18}')^{(2)} - (b_{18}'')^{(2)}\big(G_{19}\big(s_{(16)}\big), s_{(16)}\big)\Big) T_{18}\big(s_{(16)}\big)\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i\colon \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \le (\,\hat{P}_{20}\,)^{(3)}\,, T_i^0 \le (\,\hat{Q}_{20}\,)^{(3)},$	
$0 \le G_i(t) - G_i^0 \le (\,\hat{P}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)} t}$	
$0 \le T_i(t) - T_i^0 \le (\,\hat{Q}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}\big(s_{(20)}\big) - \Big((a_{20}')^{(3)} + a_{20}'')^{(3)}\big(T_{21}\big(s_{(20)}\big), s_{(20)}\big)\Big) G_{20}\big(s_{(20)}\big)\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}\big(s_{(20)}\big) - \Big((a_{21}')^{(3)} + (a_{21}'')^{(3)}\big(T_{21}\big(s_{(20)}\big), s_{(20)}\big)\Big) G_{21}\big(s_{(20)}\big)\right] ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{32})^{(6)}$, $T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \le (\hat{P}_{36})^{(7)} \, , T_i^0 \le (\hat{Q}_{36})^{(7)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}')^{(7)} + a_{36}'')^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}')^{(7)} + (a_{37}'')^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}')^{(7)} + (a_{38}'')^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}')^{(7)} - (b_{36}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}')^{(7)} - (b_{37}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}')^{(7)} - (b_{38}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i \, , T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \le (\hat{P}_{40})^{(8)} \, , T_i^0 \le (\hat{Q}_{40})^{(8)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}')^{(8)} + a_{40}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}')^{(8)} + (a_{41}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}\left(s_{(40)}\right) - \left((a_{42}')^{(8)} + (a_{42}'')^{(8)}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{42}\left(s_{(40)}\right)\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}\left(s_{(40)}\right) - \left((b_{40}')^{(8)} - (b_{40}'')^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{40}\left(s_{(40)}\right)\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}\left(s_{(40)}\right) - \left((b_{41}')^{(8)} - (b_{41}'')^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{41}\left(s_{(40)}\right)\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}\left(s_{(40)}\right) - \left((b_{42}')^{(8)} - (b_{42}'')^{(8)}\left(G_{43}\left(s_{(40)}\right), s_{(40)}\right)\right) T_{42}\left(s_{(40)}\right)\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}\left(s_{(44)}\right) - \left((a_{44}')^{(9)} + a_{44}'')^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{44}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}\left(s_{(44)}\right) - \left((a_{45}')^{(9)} + (a_{45}'')^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{45}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}\left(s_{(44)}\right) - \left((a_{46}')^{(9)} + (a_{46}'')^{(9)}\left(T_{45}\left(s_{(44)}\right), s_{(44)}\right)\right) G_{46}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}\left(s_{(44)}\right) - \left((b_{44}')^{(9)} - (b_{44}'')^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{44}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}\left(s_{(44)}\right) - \left((b_{45}')^{(9)} - (b_{45}'')^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{45}\left(s_{(44)}\right)\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}\left(s_{(44)}\right) - \left((b_{46}')^{(9)} - (b_{46}'')^{(9)}\left(G_{47}\left(s_{(44)}\right), s_{(44)}\right)\right) T_{46}\left(s_{(44)}\right)\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that	168

$(G_{13}(t)-G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)}+G_{14}^0\right)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)}+(\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0+\int_0^t\left[(a_{16})^{(2)}\left(G_{17}^0+(\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right]ds_{(16)}=$ $\left(1+(a_{16})^{(2)}t\right)G_{17}^0+\frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t}-1\right)$	169
From which it follows that $(G_{16}(t)-G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)}+G_{17}^0\right)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)}+(\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0+\int_0^t\left[(a_{20})^{(3)}\left(G_{21}^0+(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right]ds_{(20)}=$ $\left(1+(a_{20})^{(3)}t\right)G_{21}^0+\frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t}-1\right)$	171
From which it follows that $(G_{20}(t)-G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{P}_{20})^{(3)}+G_{21}^0\right)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)}+(\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0+\int_0^t\left[(a_{24})^{(4)}\left(G_{25}^0+(\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right]ds_{(24)}=$ $\left(1+(a_{24})^{(4)}t\right)G_{25}^0+\frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t}-1\right)$	173
From which it follows that $(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

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Indeed if we denote

Definition of $\widetilde{(G_{27})}, \widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})}, \widetilde{(T_{27})} \right) = \mathcal{A}^{(4)}((G_{27}), (T_{27}))$

It results

$$\left|\tilde{G}_{24}^{(1)} - \tilde{G}_{i}^{(2)}\right| \leq \int_0^t (a_{24})^{(4)} \left|G_{25}^{(1)} - G_{25}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \, ds_{(24)} +$$

$$\int_0^t \{(a'_{24})^{(4)} \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$(a''_{24})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right) \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$G_{24}^{(2)} |(a''_{24})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right) - (a''_{24})^{(4)}\left(T_{25}^{(2)}, s_{(24)}\right)| \; e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \} ds_{(24)}$$

Where $s_{(24)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on Equations it follows

$$\left|(G_{27})^{(1)} - (G_{27})^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} t} \leq$$
$$\frac{1}{(\widehat{M}_{24})^{(4)}} \left((a_{24})^{(4)} + (a'_{24})^{(4)} + (\widehat{A}_{24})^{(4)} + (\widehat{P}_{24})^{(4)} (\widehat{k}_{24})^{(4)}\right) d\left(\left((G_{27})^{(1)}, (T_{27})^{(1)}; \; (G_{27})^{(2)}, (T_{27})^{(2)}\right)\right)$$ 226

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Remark 16: The fact that we supposed $(a''_{24})^{(4)}$ and $(b''_{24})^{(4)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ *and* $(\widehat{Q}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ respectively of $\mathbb{R}_+$. 227

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Remark 17: There does not exist any t where $G_i\,(t) = 0$ *and* $T_i\,(t) = 0$ 228

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$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(4)} - (a''_i)^{(4)}(T_{25}(s_{(24)}), s_{(24)})\} ds_{(24)}\right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{(-(b'_i)^{(4)} t)} > 0 \quad \text{for } \mathrm{t} > 0$$

Definition of $\left((\widehat{M}_{24})^{(4)}\right)_1, \left((\widehat{M}_{24})^{(4)}\right)_2$ *and* $\left((\widehat{M}_{24})^{(4)}\right)_3$: 229

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$G_{24} < (\widehat{M}_{24})^{(4)}$ it follows $\frac{dG_{25}}{dt} \leq \left((\widehat{M}_{24})^{(4)}\right)_1 - (a'_{25})^{(4)} G_{25}$ and by integrating

$$G_{25} \leq \left((\widehat{M}_{24})^{(4)}\right)_2 = G_{25}^0 + 2(a_{25})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_1 / (a'_{25})^{(4)}$$

In the same way , one can obtain $G_{26} \leq \left((\widehat{M}_{24})^{(4)}\right)_3 = G_{26}^0 + 2(a_{26})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_2/(a_{26}^{'})^{(4)}$ If G_{25} or G_{26} is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.	
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In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
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$T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(7)} t\right)} > 0 \quad \text{for } t > 0$	
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{Q}_{40})^{(8)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
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$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})},\widetilde{(T_{47})}$: $(\widetilde{(G_{47})},\widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}),(T_{47}))$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)}\left|G_{45}^{(1)} - G_{45}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t\{(a_{44}')^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a_{44}'')^{(9)}(T_{45}^{(1)},s_{(44)})\left|G_{44}^{(1)} - G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}\left|(a_{44}'')^{(9)}(T_{45}^{(1)},s_{(44)}) - (a_{44}'')^{(9)}(T_{45}^{(2)},s_{(44)})\right|\ e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ *and* $(\hat{Q}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}$, $i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on t*) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G,t) - (b''_{14})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
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$\left(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}\left((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)}\right)}\left[e^{\left((S_1)^{(1)}-(p_{13})^{(1)}\right)t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}\left((S_1)^{(1)}-(a'_{15})^{(1)}\right)}\left[e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}\right] + G_{15}^0 e^{-(a'_{15})^{(1)}t}\right)$	286

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$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
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$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(\mathrm{T}_{17}, t) + (a_{17}'')^{(2)}(\mathrm{T}_{17}, t) \leq -(\sigma_1)^{(2)}$	293
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By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
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Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)},\ \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)},$ and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)},\ \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)},$ and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)} t}$	310
$(p_i)^{(2)}$ is defined by equation	
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$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})} \left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)} t} \right] + G_{18}^0 e^{-(S_2)^{(2)} t} \leq G_{18}(t) \leq \right.$ $\left. \frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a'_{18})^{(2)})} \left[e^{(S_1)^{(2)} t} - e^{-(a'_{18})^{(2)} t} \right] + G_{18}^0 e^{-(a'_{18})^{(2)} t} \right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)} t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)} t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b'_{18})^{(2)})} \left[e^{(R_1)^{(2)} t} - e^{-(b'_{18})^{(2)} t} \right] + T_{18}^0 e^{-(b'_{18})^{(2)} t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)} + (r_{16})^{(2)} + (R_2)^{(2)})} \left[e^{((R_1)^{(2)} + (r_{16})^{(2)})t} - e^{-(R_2)^{(2)} t} \right] + T_{18}^0 e^{-(R_2)^{(2)} t}$	315
<u>Definition of</u> $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)} (m_2)^{(2)} - (a'_{16})^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}^{'})^{(2)}$ $(R_2)^{(2)} = (b_{18}^{'})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} - (a_{20}^{''})^{(3)}(T_{21}, t) + (a_{21}^{''})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}, t) - (b_{21}^{''})^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)}, \ \boldsymbol{if} \ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}, \boldsymbol{if} \ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
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$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \textbf{\textit{if}}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a'_{22})^{(3)})}[e^{(S_1)^{(3)}t} - e^{-(a'_{22})^{(3)}t}] + G_{22}^0 e^{-(a'_{22})^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b'_{22})^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b'_{22})^{(3)}t}\right] + T_{22}^0 e^{-(b'_{22})^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
<u>**Behavior of the solutions of equation**</u> <u>**Theorem:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
<u>**Definition of**</u> $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations	329

$(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_1)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	
Definition of $(\bar{\nu}_1)^{(4)},,(\bar{\nu}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)}>0,(\bar{\nu}_2)^{(4)}<0$ and respectively $(\bar{u}_1)^{(4)}>0,(\bar{u}_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_2)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(\nu_0)^{(4)},(m_1)^{(4)}=(\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)}<(\nu_1)^{(4)}$ $(m_2)^{(4)}=(\nu_1)^{(4)},(m_1)^{(4)}=(\bar{\nu}_1)^{(4)},\boldsymbol{if}\ (\nu_4)^{(4)}<(\nu_0)^{(4)}<(\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(\nu_4)^{(4)},(m_1)^{(4)}=(\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)}<(\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar{u}_1)^{(4)},\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)}=\frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(u_0)^{(4)},\boldsymbol{if}\ (\bar{u}_1)^{(4)}<(u_0)^{(4)}$ where $(u_1)^{(4)},(\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0e^{((S_1)^{(4)}-(p_{24})^{(4)})t}\leq G_{24}(t)\leq G_{24}^0e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}}G_{24}^0e^{((S_1)^{(4)}-(p_{24})^{(4)})t}\leq G_{25}(t)\leq\frac{1}{(m_2)^{(4)}}G_{24}^0e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t}-e^{-(S_2)^{(4)}t}\right]+G_{26}^0e^{-(S_2)^{(4)}t}\leq G_{26}(t)\leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq T_{24}^0e^{((R_1)^{(4)}+(r_{24})^{(4)})t}}$	
$\frac{1}{(\mu_1)^{(4)}}T_{24}^0e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq\frac{1}{(\mu_2)^{(4)}}T_{24}^0e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0e^{-(b_{26}')^{(4)}t}\leq T_{26}(t)\leq$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}')^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}')^{(4)}$ $(R_2)^{(4)}=(b_{26}')^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\le-(a_{28}')^{(5)}+(a_{29}')^{(5)}-(a_{28}'')^{(5)}(T_{29},t)+(a_{29}'')^{(5)}(T_{29},t)\le-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\le-(b_{28}')^{(5)}+(b_{29}')^{(5)}-(b_{28}'')^{(5)}\big((G_{31}),t\big)-(b_{29}'')^{(5)}\big((G_{31}),t\big)\le-(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\big(\nu^{(5)}\big)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\big(u^{(5)}\big)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar\nu_1)^{(5)},,(\bar\nu_2)^{(5)},(\bar u_1)^{(5)},(\bar u_2)^{(5)}$: By $(\bar\nu_1)^{(5)}>0,(\bar\nu_2)^{(5)}<0$ and respectively $(\bar u_1)^{(5)}>0,(\bar u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\big(\nu^{(5)}\big)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\big(u^{(5)}\big)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar\nu_1)^{(5)},$ ***if*** $(\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar\nu_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},$ ***if*** $(\bar\nu_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \le G_{28}(t) \le G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \le G_{29}(t) \le \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \le G_{30}(t) \le\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \le T_{30}(t) \le$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} - (a_{32}^{''})^{(6)}(T_{33},t) + (a_{33}^{''})^{(6)}(T_{33},t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b_{32}^{'})^{(6)} + (b_{33}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35}),t) - (b_{33}^{''})^{(6)}((G_{35}),t) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}$, $(m_2)^{(6)}$, $(\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}$, $(m_2)^{(6)}$, $(\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}$, $\boldsymbol{if}$ $(\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}$, $\boldsymbol{if}$ $(\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}$, $\boldsymbol{if}$ $(u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}$, $\boldsymbol{if}$ $(u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)}G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)}T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)}T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)} t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)} t}$	365
$(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})} \left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)} t} \right] + G_{38}^0 e^{-(S_2)^{(7)} t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}^{'})^{(7)})} [e^{(S_1)^{(7)} t} - e^{-(a_{38}^{'})^{(7)} t}] + G_{38}^0 e^{-(a_{38}^{'})^{(7)} t})$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}^{'})^{(7)})} \left[e^{(R_1)^{(7)} t} - e^{-(b_{38}^{'})^{(7)} t} \right] + T_{38}^0 e^{-(b_{38}^{'})^{(7)} t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)} + (r_{36})^{(7)} + (R_2)^{(7)})} \left[e^{((R_1)^{(7)} + (r_{36})^{(7)})t} - e^{-(R_2)^{(7)} t} \right] + T_{38}^0 e^{-(R_2)^{(7)} t}$	369
<u>**Definition of**</u> $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)} (m_2)^{(7)} - (a_{36}^{'})^{(7)}$	370

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)}$ $(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$	
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} - (a_{40}^{''})^{(8)}(T_{41}, t) + (a_{41}^{''})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (b_{40}^{''})^{(8)}\big((G_{43}), t\big) - (b_{41}^{''})^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
Definition of $(\bar{\nu}_1)^{(8)}, , (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}, \ \boldsymbol{if} \ (\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}, \boldsymbol{if} \ (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0 e^{-(S_2)^{(9)}t} \le G_{46}(t) \le$$

$$\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a'_{46})^{(9)})}\left[e^{(S_1)^{(9)}t}-e^{-(a'_{46})^{(9)}t}\right]+ G_{46}^0 e^{-(a'_{46})^{(9)}t}\Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \le T_{44}(t) \le T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}}T_{44}^0 e^{(R_1)^{(9)}t} \le T_{44}(t) \le \frac{1}{(\mu_2)^{(9)}}T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b'_{46})^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b'_{46})^{(9)}t}\right]+T_{46}^0 e^{-(b'_{46})^{(9)}t} \le T_{46}(t) \le$$

$$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a'_{44})^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b'_{44})^{(9)}$

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right) - (a_{14}^{''})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
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Definition of $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
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In the same manner , we get	391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}$	
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If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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Proof : From global equations we obtain	398

$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}^{'})^{(3)} - (a_{21}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right) - (a_{21}^{''})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:-	403

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

<u>Proof</u> : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

<u>Definition of</u> $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

<u>Definition of</u> $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \le \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \le \nu^{(4)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \le (\bar{\nu}_1)^{(4)} \le \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \le \nu^{(4)}(t) \le \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \le (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \le \nu^{(4)}(t) \le (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \le u^{(4)}(t) \le (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \le \frac{d\nu^{(5)}}{dt} \le -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{5 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}}{1 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>Proof</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ **<u>Definition of</u>** $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains **<u>Definition of</u>** $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(6)}(t)$:- $(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(6)}(t)$:- $(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .** Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.	
Proof : From global equations we obtain $$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$ **Definition of** $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$ It follows $$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:- For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$ $$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$ it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$	416
In the same manner , we get	417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain 419

$$(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(7)}(t)$:-

$(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)},\ \boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(7)}(t)$:- 420

$(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)},\ \boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)} G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .**

Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)} T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$**, and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$ if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

$with\ \ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}')^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}')^{(6)}(r_{33})^{(6)} - (b_{33}')^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ *with* $(p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ *with* $(p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ *with* $(p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)}$ *and* $(b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27}))]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}')^{(4)} - (b_{25}'')^{(4)}((G_{27}))]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27}))]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - [(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29})]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - [(a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29})]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - [(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29})]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}')^{(5)} - (b_{28}'')^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}')^{(5)} - (b_{29}'')^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}')^{(5)} - (b_{30}'')^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - [(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33})]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - [(a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33})]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - [(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33})]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}')^{(6)} - (b_{32}'')^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}')^{(6)} - (b_{33}'')^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}')^{(6)} - (b_{34}'')^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - [(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37})]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - [(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37})]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (bb) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) +$	486

$(a_{16}'')^{(2)}(T_{17})(a_{17}'')^{(2)}(T_{17})=0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23})=(a_{20}')^{(3)}(a_{21}')^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}+(a_{20}')^{(3)}(a_{21}'')^{(3)}(T_{21})+(a_{21}')^{(3)}(a_{20}'')^{(3)}(T_{21})+$ $(a_{20}'')^{(3)}(T_{21})(a_{21}'')^{(3)}(T_{21})=0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27})=(a_{24}')^{(4)}(a_{25}')^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}+(a_{24}')^{(4)}(a_{25}'')^{(4)}(T_{25})+(a_{25}')^{(4)}(a_{24}'')^{(4)}(T_{25})+$ $(a_{24}'')^{(4)}(T_{25})(a_{25}'')^{(4)}(T_{25})=0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31})=(a_{28}')^{(5)}(a_{29}')^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}+(a_{28}')^{(5)}(a_{29}'')^{(5)}(T_{29})+(a_{29}')^{(5)}(a_{28}'')^{(5)}(T_{29})+$ $(a_{28}'')^{(5)}(T_{29})(a_{29}'')^{(5)}(T_{29})=0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35})=(a_{32}')^{(6)}(a_{33}')^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}+(a_{32}')^{(6)}(a_{33}'')^{(6)}(T_{33})+(a_{33}')^{(6)}(a_{32}'')^{(6)}(T_{33})+$ $(a_{32}'')^{(6)}(T_{33})(a_{33}'')^{(6)}(T_{33})=0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39})=(a_{36}')^{(7)}(a_{37}')^{(7)}-(a_{36})^{(7)}(a_{37})^{(7)}+(a_{36}')^{(7)}(a_{37}'')^{(7)}(T_{37})+(a_{37}')^{(7)}(a_{36}'')^{(7)}(T_{37})+$ $(a_{36}'')^{(7)}(T_{37})(a_{37}'')^{(7)}(T_{37})=0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43})=(a_{40}')^{(8)}(a_{41}')^{(8)}-(a_{40})^{(8)}(a_{41})^{(8)}+(a_{40}')^{(8)}(a_{41}'')^{(8)}(T_{41})+(a_{41}')^{(8)}(a_{40}'')^{(8)}(T_{41})+$ $(a_{40}'')^{(8)}(T_{41})(a_{41}'')^{(8)}(T_{41})=0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47})=(a_{44}')^{(9)}(a_{45}')^{(9)}-(a_{44})^{(9)}(a_{45})^{(9)}+(a_{44}')^{(9)}(a_{45}'')^{(9)}(T_{45})+(a_{45}')^{(9)}(a_{44}'')^{(9)}(T_{45})+$ $(a_{44}'')^{(9)}(T_{45})(a_{45}'')^{(9)}(T_{45})=0$	492 A

Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*})=0$. With this value , we obtain from the three first equations $G_{13}=\frac{(a_{13})^{(1)}G_{14}}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^{*})]}$, $G_{15}=\frac{(a_{15})^{(1)}G_{14}}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*})=0$. With this value , we obtain from the three first equations	494
$G_{16}=\frac{(a_{16})^{(2)}G_{17}}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^{*})]}$, $G_{18}=\frac{(a_{18})^{(2)}G_{17}}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*})=0$. With this value , we obtain from the three first equations $G_{20}=\frac{(a_{20})^{(3)}G_{21}}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^{*})]}$, $G_{22}=\frac{(a_{22})^{(3)}G_{21}}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*})=0$. With this value , we obtain from the three first equations $G_{24}=\frac{(a_{24})^{(4)}G_{25}}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26}=\frac{(a_{26})^{(4)}G_{25}}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*})=0$. With this value , we obtain from the three first equations $G_{28}=\frac{(a_{28})^{(5)}G_{29}}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30}=\frac{(a_{30})^{(5)}G_{29}}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*})=0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	
Definition and uniqueness of T_{37}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$	500
Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right]+(b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right]+(b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right] + (b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27}) + (b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right] + (b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*}) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31}) + (b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right] + (b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*}) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35}) + (b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right] + (b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*}) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39}) + (b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right] + (b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*}) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43})=(b'_{40})^{(8)}(b'_{41})^{(8)}-(b_{40})^{(8)}(b_{41})^{(8)}-$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43})+(b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right]+(b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43})=0$ Where in $(G_{43})(G_{40},G_{41},G_{42}),G_{40},G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0)>0\,,\varphi(\infty)\;<0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*)=0$	
By the same argument, the equations 92,93 admit solutions G_{44},G_{45} if $\varphi(G_{47})=(b'_{44})^{(9)}(b'_{45})^{(9)}-(b_{44})^{(9)}(b_{45})^{(9)}-$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47})+(b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right]+(b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47})=0$ Where in $(G_{47})(G_{44},G_{45},G_{46}),G_{44},G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0)>0\,,\varphi(\infty)\;<0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*)=0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*)=0$, T_{14}^* given by $f(T_{14}^*)=0$ and $G_{13}^*=\frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^*=\frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^*=\frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^*=\frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*)=0$, T_{17}^* given by $f(T_{17}^*)=0$ and	512
$G_{16}^*=\frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^*=\frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^*=\frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^*=\frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*)=0$, T_{21}^* given by $f(T_{21}^*)=0$ and $G_{20}^*=\frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^*=\frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^*=\frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^*=\frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote <u>**Definition of**</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS <u>**Theorem 4:**</u> If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}} (T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j} ((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)} G_{17}^* \mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)} G_{18}^* \mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)} T_{16}^* \mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)} T_{17}^* \mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)} T_{18}^* \mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}} (T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j} ((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)} G_{20}^* \mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)} G_{21}^* \mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)} G_{22}^* \mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)} T_{20}^* \mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	547
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial(b_i^{''})^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 5:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	555
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial(b_i^{''})^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*}) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}\left(\left(G_{35}\right)^{*}\right) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **<u>Theorem 8:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}(\,(G_{43})^*\,) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **<u>Proof:</u> Denote**	586 A
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^*\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*} + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$

$+((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}) \left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\} = 0$

$+$

$((\lambda)^{(2)} + (b_{18}^{'})^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a_{18}^{'})^{(2)} + (p_{18})^{(2)})$

$\left[\left(\left((\lambda)^{(2)} + (a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*} + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)} + (a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*} + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right) (q_{18})^{(2)}\mathrm{G}_{18}$

$+((\lambda)^{(2)} + (a_{16}^{'})^{(2)} + (p_{16})^{(2)}) \left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\} = 0$

$+$

$((\lambda)^{(3)} + (b_{22}^{'})^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a_{22}^{'})^{(3)} + (p_{22})^{(3)})$

$\left[\left(\left((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)} + (a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*} + (a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$

$\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$

$\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2 + \left((b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)})s_{(21),(22)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\} = 0$ +	
$((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$ $\left(\left((\lambda)^{(5)}\right)^2 + \left((b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$ $+\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right) (q_{30})^{(5)} G_{30}$ $+((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)}) \left((a_{30})^{(5)}(q_{29})^{(5)} G_{29}^{*} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)} G_{28}^{*}\right)$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}) s_{(29),(30)} T_{29}^{*} + (b_{29})^{(5)} s_{(28),(30)} T_{28}^{*}\right)\} = 0$ +	
$((\lambda)^{(6)} + (b_{34}^{'})^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a_{34}^{'})^{(6)} + (p_{34})^{(6)})$ $\left[\left(((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)})(q_{33})^{(6)} G_{33}^{*} + (a_{33})^{(6)}(q_{32})^{(6)} G_{32}^{*}\right)\right]$ $\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}) s_{(33),(33)} T_{33}^{*} + (b_{33})^{(6)} s_{(32),(33)} T_{33}^{*}\right)$ $+\left(((\lambda)^{(6)} + (a_{33}^{'})^{(6)} + (p_{33})^{(6)})(q_{32})^{(6)} G_{32}^{*} + (a_{32})^{(6)}(q_{33})^{(6)} G_{33}^{*}\right)$ $\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}) s_{(33),(32)} T_{33}^{*} + (b_{33})^{(6)} s_{(32),(32)} T_{32}^{*}\right)$ $\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$ $\left(\left((\lambda)^{(6)}\right)^2 + \left((b_{32}^{'})^{(6)} + (b_{33}^{'})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$ $+\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right) (q_{34})^{(6)} G_{34}$ $+((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)}) \left((a_{34})^{(6)}(q_{33})^{(6)} G_{33}^{*} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)} G_{32}^{*}\right)$ $\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)}) s_{(33),(34)} T_{33}^{*} + (b_{33})^{(6)} s_{(32),(34)} T_{32}^{*}\right)\} = 0$ + $((\lambda)^{(7)} + (b_{38}^{'})^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a_{38}^{'})^{(7)} + (p_{38})^{(7)})$ $\left[\left(((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)})(q_{37})^{(7)} G_{37}^{*} + (a_{37})^{(7)}(q_{36})^{(7)} G_{36}^{*}\right)\right]$ $\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}) s_{(37),(37)} T_{37}^{*} + (b_{37})^{(7)} s_{(36),(37)} T_{37}^{*}\right)$ $+\left(((\lambda)^{(7)} + (a_{37}^{'})^{(7)} + (p_{37})^{(7)})(q_{36})^{(7)} G_{36}^{*} + (a_{36})^{(7)}(q_{37})^{(7)} G_{37}^{*}\right)$ $\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}) s_{(37),(36)} T_{37}^{*} + (b_{37})^{(7)} s_{(36),(36)} T_{36}^{*}\right)$	

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\} = 0$$

$+$

$$\left((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\{\left((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$$

$+$

$$\left((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\{\left((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(44)}T^*_{45} + (b_{45})^{(9)}s_{(44),(44)}T^*_{44}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2 + \left((b'_{44})^{(9)} + (b'_{45})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)}\right) (\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^2 + \left((a'_{44})^{(9)} + (a'_{45})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)}\right) (\lambda)^{(9)}\right) (q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)} + (a'_{44})^{(9)} + (p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G^*_{45} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G^*_{44}\right)$$

$$\left(\left((\lambda)^{(9)} + (b'_{44})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(46)}T^*_{45} + (b_{45})^{(9)}s_{(44),(46)}T^*_{44}\right)\} = 0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION TWENTY NINE

Quantum Mechanics And Gravity Can Seem To Contradict Each Other

INTRODUCTION—VARIABLES USED

Holographic description of a quantum black hole on a computer Masanori Hanada1, 2, 3,*, Yoshifumi Hyakutake4, Goro Ishiki1, Jun Nishimura5,6 Science 23 May 2014: Vol. 344, Issue 6186, pp. 882-885 DOI: 10.1126/science.1250122

(1) Superstring theory, a consistent theory of quantum gravity, provides (eb) a possible solution to the paradox if (e) evaporating black holes can actually be described in terms of (e&eb) standard quantum mechanical systems, as conjectured from (e) the theory.

(2) Here, authors test this conjecture by calculating the mass of a black hole in (e&eb) the corresponding quantum mechanical system numerically.

(3) Results agree well with (eb) the prediction from gravity theory, including (e) the leading quantum gravity correction.

(4) Ability to simulate (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics.

(5) Quantum mechanics and (e&eb) gravity can seem to contradict each other.

(6) Superstring theory may provide (eb) a route to reconcile the two, thanks to (e) the gauge/gravity duality conjecture, which allows (eb) the system to be described mathematically.

(7) However, this conjecture has yet to be formally confirmed. Hanada et al. (see the Perspective by Maldacena) performed a simulation of (e&eb) the dual gauge theory in the parameter regime that corresponds to (e&eb) a quantum black hole.

(8) Their results agree with (eb) a prediction for an evaporating black hole, including (e) quantum gravity corrections, confirming that (eb) the dual gauge theory indeed provides (eb) a complete description of the quantum nature of (e) the evaporating black hole. Science, this issue p. 882; see also p. 806

NOTATION

Module One

Black holes have been predicted to radiate particles and eventually evaporate which has led to the information loss paradox and implies (eb) that the fundamental laws of quantum mechanics may be (=) violated

G_{13} : Category one of Black holes have been predicted to radiate particles and eventually evaporate which has led to the information loss paradox

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of fundamental laws of quantum mechanics may be (=) violated

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

Black holes have been predicted to radiate particles and eventually evaporate which has led to the information loss paradox and implies that the fundamental laws of quantum mechanics may be (=) violated

G_{16} : Category one of Black holes have been predicted to radiate particles and eventually evaporate which has led to the information loss paradox and implies that the fundamental laws of quantum mechanics

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of violated

T_{17} : Category two of SAS

T_{18} : Category three of SAS

Module three

Superstring theory, a consistent theory of quantum gravity, provides (eb) a possible solution to the paradox if (e) evaporating black holes can actually be described in terms of (e&eb) standard quantum mechanical systems, as conjectured from (e) the theory

G_{20} : Category one of Superstring theory, a consistent theory of quantum gravity

G_{21} : Category two of SAS

G_{22} : Category three of SAS

T_{20} : Category one of possible solution to the paradox if (e) evaporating black holes can actually be

described in terms of (e&eb) standard quantum mechanical systems, as conjectured from (e) the theory T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Superstring theory, a consistent theory of quantum gravity, provides a possible solution to the paradox if (e) evaporating black holes can actually be described in terms of (e&eb) standard quantum mechanical systems, as conjectured from (e) the theory	
G_{24} : Category one of evaporating black holes can actually be described in terms of (e&eb) standard quantum mechanical systems, as conjectured from (e) the theory G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of Superstring theory, a consistent theory of quantum gravity, provides a possible solution to the paradox T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Superstring theory, a consistent theory of quantum gravity, provides a possible solution to the paradox if evaporating black holes can actually be described in terms of (e&eb) standard quantum mechanical systems, as conjectured from (e) the theory	
G_{28} : Category one of **Superstring theory, a consistent** standard quantum mechanical systems, as conjectured from the theory **t theory of quantum gravity, provides a possible solution to the paradox if evaporating black holes;** G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of standard quantum mechanical systems, as conjectured from (e) the theory **;Superstring theory, a consistent theory of quantum gravity, provides a possible solution to the paradox if evaporating black holes** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six Here, authors test this conjecture by calculating the mass of a black hole in (e&eb) the corresponding quantum mechanical system numerically	
G_{32} : Category one of **test this conjecture by calculating the mass of a black hole;** corresponding	

quantum mechanical system numerically G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of corresponding quantum mechanical system numerically **;test this conjecture by calculating the mass of a black hole** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven Results agree well with (eb) the prediction from gravity theory, including (e) the leading quantum gravity correction	
G_{36} : Category one of Results G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of prediction from gravity theory, including the leading quantum gravity correction T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight **Ability to simulate** (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics	
G_{40} : Category one of **Ability to simulate;** black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics; **Ability to simulate** T_{41} : Category two of SAS	

T_{42} : Category three of SAS

Module Nine

Ability to simulate black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics

G_{44} : Category one of Ability to simulate black holes

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:

$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$:
$(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$
$(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$,
$(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$
$(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$
$(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$
$(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$

are Accentuation coefficients
$(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$
, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$
$(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$,
$(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$
$(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$,
$(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$,
$(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$,
are Dissipation coefficients

Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G, t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b_{14}')^{(1)} - (b_{14}'')^{(1)}(G, t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G, t) \right] T_{15}$	6
$+(a_{13}'')^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b_{13}'')^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}, t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17}, t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}, t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b_{16}')^{(2)} - (b_{16}'')^{(2)}\left((G_{19}), t \right) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b_{17}')^{(2)} - (b_{17}'')^{(2)}\left((G_{19}), t \right) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b_{18}')^{(2)} - (b_{18}'')^{(2)}\left((G_{19}), t \right) \right] T_{18}$	12
$+(a_{16}'')^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b_{16}'')^{(2)}\left((G_{19}), t \right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}, t) \right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a_{21}')^{(3)} + (a_{21}'')^{(3)}(T_{21}, t) \right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}, t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23}, t) \right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}, t) \right] T_{22}$	18
$+(a_{20}'')^{(3)}(T_{21}, t) =$ First augmentation factor	
$-(b_{20}'')^{(3)}(G_{23}, t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}, t) \right] G_{24}$	19

$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25},t)\right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25},t)\right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)}\left((G_{27}),t\right)\right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)}\left((G_{27}),t\right)\right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b_{26}')^{(4)} - (b_{26}'')^{(4)}\left((G_{27}),t\right)\right] T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25},t) =$ First augmentation factor	
$-(b_{24}'')^{(4)}\left((G_{27}),t\right) =$ First detritions factor	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29},t)\right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29},t)\right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29},t)\right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b_{28}')^{(5)} - (b_{28}'')^{(5)}\left((G_{31}),t\right)\right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b_{29}')^{(5)} - (b_{29}'')^{(5)}\left((G_{31}),t\right)\right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b_{30}')^{(5)} - (b_{30}'')^{(5)}\left((G_{31}),t\right)\right] T_{30}$	30
$+(a_{28}'')^{(5)}(T_{29},t) =$ First augmentation factor	
$-(b_{28}'')^{(5)}\left((G_{31}),t\right) =$ First detritions factor	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33},t)\right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33},t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}')^{(6)} - (b_{32}'')^{(6)}\left((G_{35}),t\right)\right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}')^{(6)} - (b_{33}'')^{(6)}\left((G_{35}),t\right)\right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}')^{(6)} - (b_{34}'')^{(6)}\left((G_{35}),t\right)\right] T_{34}$	36
$+(a_{32}'')^{(6)}(T_{33},t) =$ First augmentation factor	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37},t)\right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37},t)\right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37},t)\right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}')^{(7)} - (b_{36}'')^{(7)}\left((G_{39}),t\right)\right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}')^{(7)} - (b_{37}'')^{(7)}\left((G_{39}),t\right)\right] T_{37}$	*41*

$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39}),t)\right]T_{38}$	42
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right]G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right]G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41},t)\right]G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43}),t)\right]T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}((G_{43}),t)\right]T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43}),t)\right]T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47}),t)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}((G_{47}),t)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47}),t)\right]T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}((G_{47}),t) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \begin{bmatrix} (a_{14}^{'})^{(1)} \boxed{+(a_{14}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \begin{bmatrix} (a_{15}^{'})^{(1)} \boxed{+(a_{15}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a_{13}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{14}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{15}^{''})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{matrix} (b'_{13})^{(1)}\boxed{-(b''_{13})^{(1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{matrix} (b'_{14})^{(1)}\boxed{-(b''_{14})^{(1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{matrix} (b'_{15})^{(1)}\boxed{-(b''_{15})^{(1)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[\begin{matrix}(a'_{16})^{(2)}\boxed{+(a''_{16})^{(2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{16}$	*61*
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[\begin{matrix}(a'_{17})^{(2)}\boxed{+(a''_{17})^{(2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{17}$	*62*
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[\begin{matrix}(a'_{18})^{(2)}\boxed{+(a''_{18})^{(2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{18}$	*63*
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[\begin{matrix}(b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,)}(G,t)}\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{16}$	*64*
$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[\begin{matrix}(b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,)}(G,t)}\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{17}$	*65*

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,)}(G,t)}\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{18}$$ 66

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)}\boxed{+(a''_{20})^{(3)}(T_{21},t)}\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{20}$$ 67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)}\boxed{+(a''_{21})^{(3)}(T_{21},t)}\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{21}$$ 68

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)}\boxed{+(a''_{22})^{(3)}(T_{21},t)}\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix}\right] G_{22}$$ 69

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3 $+(a''_{40})^{(8,8,8,8)}(T_{41},t)$,$+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3 $+(a''_{44})^{(9,9,9)}(T_{45},t)$,$+(a''_{45})^{(9,9,9)}(T_{45},t)$,$+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} -(b''_{20})^{(3)}(G_{23},t) -(b''_{16})^{(2,2,2)}(G_{19},t) -(b''_{13})^{(1,1,1,)}(G,t) \\ -(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8,8)}(G_{43},t) -(b''_{44})^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{20}$	70
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} -(b''_{21})^{(3)}(G_{23},t) -(b''_{17})^{(2,2,2)}(G_{19},t) -(b''_{14})^{(1,1,1,)}(G,t) \\ -(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t) -(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t) -(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{37})^{(7,7,7,7)}(G_{39},t) -(b''_{41})^{(8,8,8,8)}(G_{43},t) -(b''_{45})^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{21}$	71
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} -(b''_{22})^{(3)}(G_{23},t) -(b''_{18})^{(2,2,2)}(G_{19},t) -(b''_{15})^{(1,1,1,)}(G,t) \\ -(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t) -(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t) -(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{38})^{(7,7,7,7)}(G_{39},t) -(b''_{42})^{(8,8,8,8)}(G_{43},t) -(b''_{46})^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{22}$	72
$-(b''_{20})^{(3)}(G_{23},t)$, $-(b''_{21})^{(3)}(G_{23},t)$, $-(b''_{22})^{(3)}(G_{23},t)$ *are first detrition coefficients for category 1, 2 and 3* $-(b''_{16})^{(2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2)}(G_{19},t)$ *are second detrition coefficients for category 1, 2 and 3* $-(b''_{13})^{(1,1,1,)}(G,t)$, $-(b''_{14})^{(1,1,1,)}(G,t)$, $-(b''_{15})^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3* $-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3* $-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3* $-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3* $-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$ $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8,8,8)}(G_{43},t)$,$-(b''_{41})^{(8,8,8,8)}(G_{43},t)$,$-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\begin{bmatrix}(a'_{24})^{(4)}\boxed{+(a''_{24})^{(4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{24} \quad 73$$

$$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\begin{bmatrix}(a'_{25})^{(4)}\boxed{+(a''_{25})^{(4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{25} \quad 74$$

$$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\begin{bmatrix}(a'_{26})^{(4)}\boxed{+(a''_{26})^{(4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category$ 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ $are\ second\ augmentation\ coefficient\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ $are\ fourth\ augmentation\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ $are\ fifth\ augmentation\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ $are\ sixth\ augmentation\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ $are\ seventh\ augmentation\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ $are\ eighth\ augmentation\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\begin{bmatrix}(b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{24} \quad 76$$

$$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\begin{bmatrix}(b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{25} \quad 77$$

$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3	

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{30}$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3	

$\boxed{-(b_{46}'')^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a_{32}')^{(6)} \boxed{+(a_{32}'')^{(6)}(T_{33},t)} \boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{32}$	85
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a_{33}')^{(6)} \boxed{+(a_{33}'')^{(6)}(T_{33},t)} \boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{33}$	86
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a_{34}')^{(6)} \boxed{+(a_{34}'')^{(6)}(T_{33},t)} \boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{34}$	87
$\boxed{+(a_{32}'')^{(6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a_{16}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a_{20}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b_{32}')^{(6)} \boxed{-(b_{32}'')^{(6)}(G_{35},t)} \boxed{-(b_{28}'')^{(5,5,5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{32}$	88

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b_{33}^{'})^{(6)}\boxed{-(b_{33}^{''})^{(6)}(G_{35},t)}\boxed{-(b_{29}^{''})^{(5,5,5)}(G_{31},t)}\boxed{-(b_{25}^{''})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$$ 89

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b_{34}^{'})^{(6)}\boxed{-(b_{34}^{''})^{(6)}(G_{35},t)}\boxed{-(b_{30}^{''})^{(5,5,5)}(G_{31},t)}\boxed{-(b_{26}^{''})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$$ 90

$\boxed{-(b_{32}^{''})^{(6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{28}^{''})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{24}^{''})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a_{36}^{'})^{(7)}\boxed{+(a_{36}^{''})^{(7)}(T_{37},t)}\boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}\boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 91

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a_{37}^{'})^{(7)}\boxed{+(a_{37}^{''})^{(7)}(T_{37},t)}\boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$ 92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[\begin{matrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$$ 93

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$ 94

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	95
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second	

augmentation coefficient for category 1, 2 and 3

$+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3

$+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ $+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ $+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for 1,2,3

$+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)$ are eighth augmentation coefficient for 1,2,3

$+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3

$-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3

$-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3

$-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a_{44}')^{(9)} \boxed{+(a_{44}'')^{(9)}(T_{45},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a_{45}')^{(9)} \boxed{+(a_{45}'')^{(9)}(T_{45},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{14}$	
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a_{46}')^{(9)} \boxed{+(a_{46}'')^{(9)}(T_{37},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{15}$	
Where $\boxed{+(a_{44}'')^{(9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b_{44}')^{(9)}\boxed{-(b_{44}'')^{(9)}(G_{47},t)} & \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b_{45}')^{(9)}\boxed{-(b_{45}'')^{(9)}(G_{47},t)} & \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}')^{(9)}\boxed{-(b_{46}'')^{(9)}(G_{47},t)} & \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b_{44}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \le (p_i)^{(1)} \le (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \le \ (r_i)^{(1)} \le (b'_i)^{(1)} \le (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\|(a''_i)^{(1)}(T'_{14},t) - (a''_i)^{(1)}(T_{14},t)\| \le (\hat{k}_{13})^{(1)}\|T_{14} - T'_{14}\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b''_i)^{(1)}(G',t) - (b''_i)^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G - G'\|\|e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a''_i)^{(1)}(T'_{14},t)$ and $(a''_i)^{(1)}(T_{14},t)$. (T'_{14},t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a''_i)^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a''_i)^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a'_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i^{'})^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i^{'})^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$	
Where we suppose	
$(a_i)^{(2)},(a_i^{'})^{(2)},(a_i^{''})^{(2)},(b_i)^{(2)},(b_i^{'})^{(2)},(b_i^{''})^{(2)}>0,\quad i,j=16,17,18$	
The functions $(a_i^{''})^{(2)},(b_i^{''})^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)},\ (r_i)^{(2)}$:	
$(a_i^{''})^{(2)}(T_{17},t)\le(p_i)^{(2)}\le(\hat{A}_{16})^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19},t)\le\ (r_i)^{(2)}\le(b_i^{'})^{(2)}\le(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i^{''})^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i^{''})^{(2)}\left((G_{19}),t\right)=\ (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	
$\|(a_i^{''})^{(2)}(T_{17}^{'},t)-(a_i^{''})^{(2)}(T_{17},t)\|\le(\hat{k}_{16})^{(2)}\|T_{17}-T_{17}^{'}\|e^{-(\hat{M}_{16})^{(2)}t}$	107
$\|(b_i^{''})^{(2)}((G_{19})^{'},t)-(b_i^{''})^{(2)}\left((G_{19}),t\right)\|<(\hat{k}_{16})^{(2)}\|\|(G_{19})-(G_{19})^{'}\|\|e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'},t)$ and$(a_i^{''})^{(2)}(T_{17},t)$. $(T_{17}^{'},t)$ and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i^{''})^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)}and\ (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16{,}17{,}18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i')^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\,(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i')^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20{,}21{,}22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21},t) \le (p_i)^{(3)} \le (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t) \le \ (r_i)^{(3)} \le (b_i')^{(3)} \le (\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}\,(T_{21},t) = (p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}\,(G_{23},t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}$ are positive constants and $i = 20{,}21{,}22$	113
They satisfy Lipschitz condition: $\lvert(a_i'')^{(3)}(T_{21}',t) - (a_i'')^{(3)}(T_{21},t)\rvert \le (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i'')^{(3)}(G_{23}',t) - (b_i'')^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and$(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)},$ are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

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Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
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$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
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Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants	129

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
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system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (QQQQQQQ) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
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Where we suppose	
$(a_i)^{(8)}, (a_i^{'})^{(8)}, (a_i^{''})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (b_i^{''})^{(8)} > 0, \quad i,j = 40,41,42$	136
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They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'}, t) - (a_i^{''})^{(8)}(T_{41}, t)\rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}^{'}\rvert e^{-(\hat{M}_{40})^{(8)} t}$	142

$\|(b_i'')^{(8)}((G_{43})',t)-(b_i'')^{(8)}((G_{43}),t)\| < (\hat{k}_{40})^{(8)}\|\|(G_{43})-(G_{43})'\|\|e^{-(\hat{M}_{40})^{(8)}t}$	143
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<u>Definition of</u> $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
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<u>Definition of</u> $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)}$, $(r_i)^{(8)}, i=40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)}+(a_i')^{(8)}+(\hat{A}_{40})^{(8)}+(\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)}+(b_i')^{(8)}+(\hat{B}_{40})^{(8)}+(\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}]<1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)}>0, \quad i,j=44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t)\leq(p_i)^{(9)}\leq(\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t)\leq (r_i)^{(9)}\leq(b_i')^{(9)}\leq(\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t)=(p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t)= (r_i)^{(9)}$ **<u>Definition of</u>** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i=44,45,46$	
They satisfy Lipschitz condition:	

$$|(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45}-T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47})-(G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)}$ *and* $(\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(p_i)^{(9)}, (r_i)^{(9)}, i=44,45,46,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i')^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i')^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t} , \quad \boxed{G_i(0)=G_i^0>0}$$

$$T_i(t) \leq (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t} , \quad \boxed{T_i(0)=T_i^0>0}$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0), T_i(0)$

$$G_i(t) \leq (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t} , \quad G_i(0)=G_i^0>0$$

$$T_i(t) \leq (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t} , \quad T_i(0)=T_i^0>0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t) \leq (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t} , \quad G_i(0)=G_i^0>0$$

$T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$,$T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$,$T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$

$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$

$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$

$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$

Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)},$

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$

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$\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$

$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$

$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$

$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$

$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$

Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$

Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)},$

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

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$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\,\hat{P}_{32}\,)^{(6)} \, , T_i^0 \leq (\,\hat{Q}_{32}\,)^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{32}\,)^{(6)} e^{(\,\hat{M}_{32}\,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{32}\,)^{(6)} e^{(\,\hat{M}_{32}\,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}\big(T_{33}(s_{(32)}), s_{(32)}\big)\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}\big(T_{33}(s_{(32)}), s_{(32)}\big)\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}\big(T_{33}(s_{(32)}), s_{(32)}\big)\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}\big(G_{35}(s_{(32)}), s_{(32)}\big)\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}')^{(6)} - (b_{33}'')^{(6)}\big(G_{35}(s_{(32)}), s_{(32)}\big)\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}')^{(6)} - (b_{34}'')^{(6)}\big(G_{35}(s_{(32)}), s_{(32)}\big)\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i \, , \, T_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\,\hat{P}_{36}\,)^{(7)} \, , T_i^0 \leq (\,\hat{Q}_{36}\,)^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{36}\,)^{(7)} e^{(\,\hat{M}_{36}\,)^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{36}\,)^{(7)} e^{(\,\hat{M}_{36}\,)^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}')^{(7)} + a_{36}'')^{(7)}\big(T_{37}(s_{(36)}), s_{(36)}\big)\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}')^{(7)} + (a_{37}'')^{(7)}\big(T_{37}(s_{(36)}), s_{(36)}\big)\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}')^{(7)} + (a_{38}'')^{(7)}\big(T_{37}(s_{(36)}), s_{(36)}\big)\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}')^{(7)} - (b_{36}'')^{(7)}\big(G_{39}(s_{(36)}), s_{(36)}\big)\right) T_{36}(s_{(36)})\right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}')^{(7)} - (b_{37}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}')^{(7)} - (b_{38}'')^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{40})^{(8)}$, $T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}')^{(8)} + a_{40}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}')^{(8)} + (a_{41}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}')^{(8)} + (a_{42}'')^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}')^{(8)} - (b_{40}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}')^{(8)} - (b_{41}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}')^{(8)} - (b_{42}'')^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$, $T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
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Definition of $((\widehat{M}_{32})^{(6)})_1, ((\widehat{M}_{32})^{(6)})_2$ *and* $((\widehat{M}_{32})^{(6)})_3$: **Remark 28:** if G_{32} is bounded, the same property have also G_{33} *and* G_{34} . indeed if $G_{32} < (\widehat{M}_{32})^{(6)}$ it follows $\frac{dG_{33}}{dt} \leq ((\widehat{M}_{32})^{(6)})_1 - (a_{33}')^{(6)} G_{33}$ and by integrating $G_{33} \leq ((\widehat{M}_{32})^{(6)})_2 = G_{33}^0 + 2(a_{33})^{(6)}((\widehat{M}_{32})^{(6)})_1/(a_{33}')^{(6)}$ In the same way , one can obtain $G_{34} \leq ((\widehat{M}_{32})^{(6)})_3 = G_{34}^0 + 2(a_{34})^{(6)}((\widehat{M}_{32})^{(6)})_2/(a_{34}')^{(6)}$ If G_{33} *or* G_{34} is bounded, the same property follows for G_{32} , G_{34} and G_{32} , G_{33} respectively.	251
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Remark 30: If T_{32} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(6)}((G_{35})(t), t)) = (b_{33}')^{(6)}$ then $T_{33} \to \infty$. **Definition of** $(m)^{(6)}$ and ε_6 :	253

Indeed let t_6 be so that for $t > t_6$

$(b_{33})^{(6)} - (b_i'')^{(6)}\left((G_{35})(t), t\right) < \varepsilon_6, T_{32}\ (t) > (m)^{(6)}$

Then $\frac{dT_{33}}{dt} \geq (a_{33})^{(6)}(m)^{(6)} - \varepsilon_6 T_{33}$ which leads to 254

$T_{33} \geq \left(\frac{(a_{33})^{(6)}(m)^{(6)}}{\varepsilon_6}\right)(1 - e^{-\varepsilon_6 t}) + T_{33}^0 e^{-\varepsilon_6 t}$ If we take t such that $e^{-\varepsilon_6 t} = \frac{1}{2}$ it results

$T_{33} \geq \left(\frac{(a_{33})^{(6)}(m)^{(6)}}{2}\right), \quad t = log\frac{2}{\varepsilon_6}$ By taking now ε_6 sufficiently small one sees that T_{33} is unbounded. The same property holds for T_{34} if $\lim_{t\to\infty}(b_{34}'')^{(6)}\left((G_{35})(t), t(t), t\right) = (b_{34}')^{(6)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations

Analogous inequalities hold also for $G_{37}, G_{38}, T_{36}, T_{37}, T_{38}$ 255

It is now sufficient to take $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$ and to choose
$(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ large to have

$$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[(\hat{P}_{36})^{(7)} + \left((\hat{P}_{36})^{(7)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{36})^{(7)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{36})^{(7)} \quad 256$$

$$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{Q}_{36})^{(7)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{36})^{(7)}\right] \leq (\hat{Q}_{36})^{(7)} \quad 257$$

In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself

The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric 258

$$d\left(\left((G_{39})^{(1)}, (T_{39})^{(1)}\right), \left((G_{39})^{(2)}, (T_{39})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\hat{M}_{36})^{(7)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\hat{M}_{36})^{(7)}t}\}$$

Indeed if we denote

<u>Definition of</u> $\widetilde{(G_{39})}, \widetilde{(T_{39})} : \left(\widetilde{(G_{39})}, \widetilde{(T_{39})}\right) = \mathcal{A}^{(7)}((G_{39}), (T_{39}))$
It results

$$\left|\tilde{G}_{36}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{36})^{(7)}\left|G_{37}^{(1)} - G_{37}^{(2)}\right|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\,ds_{(36)} +$$
$$\int_0^t\{(a_{36}')^{(7)}\left|G_{36}^{(1)} - G_{36}^{(2)}\right|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{-(\hat{M}_{36})^{(7)}s_{(36)}} +$$
$$(a_{36}'')^{(7)}\left(T_{37}^{(1)}, s_{(36)}\right)\left|G_{36}^{(1)} - G_{36}^{(2)}\right|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}} +$$

$G_{36}^{(2)}\lvert(a_{36}'')^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)-(a_{36}'')^{(7)}\left(T_{37}^{(2)},s_{(36)}\right)\rvert\ e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	
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Remark 32: There does not exist any t where $G_i\ (t)=0\ and\ T_i\ (t)=0$ it results $G_i\ (t)\geq G_i^0 e^{\left[-\int_0^t\{(a_i')^{(7)}-(a_i'')^{(7)}(T_{37}(s_{(36)}),s_{(36)})\}ds_{(36)}\right]}\geq 0$ $T_i\ (t)\geq T_i^0 e^{(-(b_i')^{(7)}t)}>0\ \ \text{for t}>0$	261
Definition of $\left((\widehat{M}_{36})^{(7)}\right)_1,\left((\widehat{M}_{36})^{(7)}\right)_2\ and\ \left((\widehat{M}_{36})^{(7)}\right)_3$: **Remark 33:** if G_{36} is bounded, the same property have also $G_{37}\ and\ G_{38}$. indeed if $G_{36}<(\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt}\leq\left((\widehat{M}_{36})^{(7)}\right)_1-(a_{37}')^{(7)}G_{37}$ and by integrating $G_{37}\leq\left((\widehat{M}_{36})^{(7)}\right)_2=G_{37}^0+2(a_{37})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_1/(a_{37}')^{(7)}$ In the same way , one can obtain $G_{38}\leq\left((\widehat{M}_{36})^{(7)}\right)_3=G_{38}^0+2(a_{38})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_2/(a_{38}')^{(7)}$ If G_{37} *or* G_{38} is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.	262
Remark 34: If G_{36} *is* bounded, from below, the same property holds for $G_{37}\ and\ G_{38}$. The proof is analogous with the preceding one. An analogous property is true if G_{37} is bounded from below.	263

Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(7)}((G_{39})(t),t)) = (b_{37}^{'})^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i^{''})^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$	264
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$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{Q}_{40})^{(8)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{40})^{(8)}\right] \leq (\hat{Q}_{40})^{(8)}$	268
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$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t}\}$	269
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It results	271

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<u>Definition of</u> $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **<u>Remark 38:</u>** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}^{'})^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}^{'})^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}^{'})^{(8)}$	276

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
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Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}\ (t) > (m)^{(8)}$	278
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$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) = \sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})}$: $\big(\widetilde{(G_{47})},\widetilde{(T_{47})}\big) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)} \left|G_{45}^{(1)} - G_{45}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}}\, ds_{(44)} +$
$\int_0^t \{(a'_{44})^{(9)} \left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)} |(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)|\ e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}}\} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$\left|(G_{47})^{(1)} - G^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} t} \leq$
$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right) d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(9)} - (a''_i)^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{\left(-(b'_i)^{(9)} t\right)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a'_{45})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a'_{45})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a'_{46})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t),t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t),t) = (b_{46}')^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
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Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
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$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
<u>Definition of</u> $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
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Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\big((G_{19}), t\big) - (b_{17}^{''})^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
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$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)},\ \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)},\ \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{16}(t) \le G_{16}^0 e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{17}(t) \le \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \le G_{18}(t) \le\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \le T_{18}(t) \le$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \le -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \le -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \le -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}((G_{23}), t) \le -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{v}_1)^{(3)} > 0$, $(\bar{v}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(v^{(3)}\right)^2 + (\sigma_2)^{(3)}v^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
Definition of $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}, \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \le G_{20}(t) \le G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \le G_{21}(t) \le \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})}\left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \le G_{22}(t) \le\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \le T_{20}(t) \le T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \le T_{20}(t) \le \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)} - (b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \le T_{22}(t) \le$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)})}\left[e^{((R_1)^{(3)} + (r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)},\ \boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)},\ \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>**Definition of**</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>**Definition of**</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}$, ***if*** $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
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Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \le G_{28}(t) \le G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \le G_{29}(t) \le \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \le G_{30}(t) \le\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
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$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \le T_{28}(t) \le \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b_{30}')^{(5)}t}\right]+T_{30}^0e^{-(b_{30}')^{(5)}t}\le T_{30}(t)\le$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0e^{-(R_2)^{(5)}t}$	347
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Definition of $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}(u^{(6)})^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},\boldsymbol{if}\ (\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \ \boldsymbol{if} \ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)} \ , \boldsymbol{if} \ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
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$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)} t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)} t}\right] + G_{34}^0 e^{-(S_2)^{(6)} t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)} t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)} + (r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)} t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)} + (r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)} - (b_{34}')^{(6)})}\left[e^{(R_1)^{(6)} t} - e^{-(b_{34}')^{(6)} t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)} t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)} + (r_{32})^{(6)} + (R_2)^{(6)})}\left[e^{((R_1)^{(6)} + (r_{32})^{(6)})t} - e^{-(R_2)^{(6)} t}\right] + T_{34}^0 e^{-(R_2)^{(6)} t}$	358
<u>**Definition of**</u> $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)} (m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)} (\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)}, , (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a'_{38})^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a'_{38})^{(7)}t}] + G_{38}^0 e^{-(a'_{38})^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b'_{38})^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b'_{38})^{(7)}t}\right] + T_{38}^0 e^{-(b'_{38})^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a'_{36})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$ $(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$	370
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Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}(\nu^{(8)})^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_1)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ and	
Definition of $(\bar{\nu}_1)^{(8)},,(\bar{\nu}_2)^{(8)},(\bar{u}_1)^{(8)},(\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)}>0$, $(\bar{\nu}_2)^{(8)}<0$ and respectively $(\bar{u}_1)^{(8)}>0$, $(\bar{u}_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_2)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_2)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)},(\mu_2)^{(8)},(\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)},(\mu_2)^{(8)}$ by $(m_2)^{(8)}=(\nu_0)^{(8)},(m_1)^{(8)}=(\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)}<(\nu_1)^{(8)}$ $(m_2)^{(8)}=(\nu_1)^{(8)},(m_1)^{(8)}=(\bar{\nu}_1)^{(8)}\ ,\boldsymbol{if}\ (\nu_1)^{(8)}<(\nu_0)^{(8)}<(\bar{\nu}_1)^{(8)},$ and $\boxed{(\nu_0)^{(8)}=\frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)}=(\nu_1)^{(8)},(m_1)^{(8)}=(\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)}<(\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)}=(u_0)^{(8)},(\mu_1)^{(8)}=(u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)}<(u_1)^{(8)}$ $(\mu_2)^{(8)}=(u_1)^{(8)},(\mu_1)^{(8)}=(\bar{u}_1)^{(8)}\ ,\boldsymbol{if}\ (u_1)^{(8)}<(u_0)^{(8)}<(\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)}=\frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)}=(u_1)^{(8)},(\mu_1)^{(8)}=(u_0)^{(8)},\boldsymbol{if}\ (\bar{u}_1)^{(8)}<(u_0)^{(8)}$ where $(u_1)^{(8)},(\bar{u}_1)^{(8)}$	374
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$\frac{1}{(m_1)^{(8)}}G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t}\le G_{41}(t)\le\frac{1}{(m_2)^{(8)}}G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t}-e^{-(S_2)^{(8)}t}\right]+G_{42}^0 e^{-(S_2)^{(8)}t}\le G_{42}(t)\le\right.$ $\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}^{'})^{(8)})}\left[e^{(S_1)^{(8)}t}-e^{-(a_{42}^{'})^{(8)}t}\right]+G_{42}^0 e^{-(a_{42}^{'})^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)}T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)}T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45},t) + (a''_{45})^{(9)}(T_{45},t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}((G_{47}),t) - (b''_{45})^{(9)}((G_{47}),t) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},$ ***if*** $(\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, ***if*** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$, and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, ***if*** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$	
and analogously $(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, ***if*** $(u_0)^{(9)} < (u_1)^{(9)}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, ***if*** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$, and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, ***if*** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively	
Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	
$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$ $\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \Big)$	
$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$ $\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
<u>Definition of</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$	

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a_{16}^{''})^{(2)} = (a_{17}^{''})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b_{16}^{''})^{(2)} = (b_{17}^{''})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}')^{(3)} - (a_{21}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right) - (a_{21}'')^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(4)}(t)$:- $(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(4)}(t)$:- $(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .** Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.	407
Proof : From global equations we obtain $\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$ **Definition of** $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$ It follows	408

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)},\quad\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)},\quad\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .** Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.	
Proof : From 99,20,44,22,23,44 we obtain $$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}$, $\boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get	

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)}=\frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0<(\nu_1)^{(9)}<(\nu_0)^{(9)}=\frac{G_{44}^0}{G_{45}^0}<(\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0<(\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)}=\frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t)=\frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t)=\frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

<u>**Particular case :**</u>

If $(a''_{44})^{(9)}=(a''_{45})^{(9)}, then\ (\sigma_1)^{(9)}=(\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)}=(\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)}=(\nu_1)^{(9)}$ then $\nu^{(9)}(t)=(\nu_0)^{(9)}$ and as a consequence $G_{44}(t)=(\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)}=(b''_{45})^{(9)}, then\ (\tau_1)^{(9)}=(\tau_2)^{(9)}$ and then $(u_1)^{(9)}=(\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)}=(u_1)^{(9)}$ then $T_{44}(t)=(u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

<u>**Theorem**</u> : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)}-(a_{13})^{(1)}(a_{14})^{(1)}<0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)}-(a_{13})^{(1)}(a_{14})^{(1)}+(a_{13})^{(1)}(p_{13})^{(1)}+(a'_{14})^{(1)}(p_{14})^{(1)}+(p_{13})^{(1)}(p_{14})^{(1)}>0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (cc) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	
Definition and uniqueness of T_{37}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$	500
Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right] + (b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right] + (b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16},G_{17},G_{18})$, G_{16},G_{18} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0)>0$, $\varphi(\infty)<0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	504
By the same argument, the equations admit solutions G_{20},G_{21} if $\varphi(G_{23})=(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23})+(b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20},G_{21},G_{22})$, G_{20},G_{22} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0$, $\varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24},G_{25} if $\varphi(G_{27})=(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27})+(b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right]+(b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24},G_{25},G_{26})$, G_{24},G_{26} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0$, $\varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28},G_{29} if $\varphi(G_{31})=(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31})+(b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right]+(b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28},G_{29},G_{30})$, G_{28},G_{30} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0$, $\varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32},G_{33} if $\varphi(G_{35})=(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35})+(b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right]+(b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32},G_{33},G_{34})$, G_{32},G_{34} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0$, $\varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*})=0$	508
By the same argument, the equations admit solutions G_{36},G_{37} if $\varphi(G_{39})=(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39})+(b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right]+(b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36},G_{37},G_{38})$, G_{36},G_{38} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0$, $\varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*})=0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right]+(b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right]+(b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}')^{(8)} - (b_{40}'')^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}')^{(8)} - (b_{42}'')^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial(b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial(a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial(b_i^{''})^{(5)}}{\partial G_j}((G_{31})^{*}) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G^*_{28}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G^*_{29}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G^*_{30}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T^*_{28}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T^*_{29}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T^*_{30}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(6)}$ *and* $(b''_i)^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{33})^{(6)}}{\partial T_{33}}(T^*_{33}) = (q_{33})^{(6)} \quad , \frac{\partial (b''_i)^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G^*_{32}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G^*_{33}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G^*_{34}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T^*_{32}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T^*_{33}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T^*_{34}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ *and* $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i^{''})^{(7)}}{\partial G_j} \left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}} (T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i^{''})^{(8)}}{\partial G_j} \left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_{+})$ then the above equilibrium point is asymptotically stable. **Proof: Denote**	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$+\Big(\big((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\big)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\Big)$

$\Big(\big((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\big)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\Big)$

$\Big(\big((\lambda)^{(1)}\big)^{2}+\big((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\big)(\lambda)^{(1)}\Big)$

$\Big(\big((\lambda)^{(1)}\big)^{2}+\big((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\big)(\lambda)^{(1)}\Big)$

$+\Big(\big((\lambda)^{(1)}\big)^{2}+\big((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\big)(\lambda)^{(1)}\Big)(q_{15})^{(1)}G_{15}$

$+\big((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\big)\big((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\big)$

$\Big(\big((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\big)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\Big)\}=0$

$+$

$\big((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\big)\{\big((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\big)$

$\Big[\Big(\big((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\big)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\Big)\Big]$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\Big)$

$+\Big(\big((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\big)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\Big)$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\Big)$

$\Big(\big((\lambda)^{(2)}\big)^{2}+\big((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\big)(\lambda)^{(2)}\Big)$

$\Big(\big((\lambda)^{(2)}\big)^{2}+\big((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\big)(\lambda)^{(2)}\Big)$

$+\Big(\big((\lambda)^{(2)}\big)^{2}+\big((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\big)(\lambda)^{(2)}\Big)(q_{18})^{(2)}\mathrm{G}_{18}$

$+\big((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\big)\big((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\big)$

$\Big(\big((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\big)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\Big)\}=0$

$+$

$\big((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\big)\{\big((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\big)$

$\Big[\Big(\big((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\big)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\Big)\Big]$

$\Big(\big((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\big)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\Big)$

$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$ +	
$((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)})\{((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)})$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)})\{((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)})$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$	

$$+\left(\left((\lambda)^{(5)}+(a_{29}')^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)}+(a_{45}')^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION THIRTY

Gauge/Gravity Duality Conjecture

INTRODUCTION—VARIABLES USED

Holographic description of a quantum black hole on a computer Masanori Hanada1, 2, 3,*, Yoshifumi Hyakutake4, Goro Ishiki1, Jun Nishimura5,6 Science 23 May 2014: Vol. 344, Issue 6186, pp. 882-885 DOI: 10.1126/science.1250122

(1) Quantum mechanics and (e&eb) gravity can seem to contradict each other.
(2) Superstring theory may provide (eb) a route to reconcile the two, thanks to (e) the gauge/gravity duality conjecture, which allows (eb) the system to be described mathematically.
(3) However, this conjecture has yet to be formally confirmed. Hanada et al. (see the Perspective by Maldacena) performed a simulation of (e&eb) the dual gauge theory in the parameter regime that corresponds to (e&eb) a quantum black hole. Their results agree with (eb) a prediction for an evaporating black hole, including (e) quantum gravity corrections, confirming that (eb) the dual gauge theory indeed provides (eb) a complete description of the quantum nature of (e) the

evaporating black hole. Science, this issue p. 882; see also p. 806	
NOTATION	
Module One Ability to simulate black holes offers the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics	
G_{13} : Category one of **Ability to simulate black holes offers the potential to further explore;** yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics; **Ability to simulate black holes offers the potential to further explore** T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics	
G_{16} : Category one of **Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity;** well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics **;Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through well-established quantum mechanics (e&eb) black holes offers (eb) the potential to further	

explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics	
G_{20} : Category one of **Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through well-established quantum mechanics;** black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics **;Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through well-established quantum mechanics** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through well-established quantum mechanics black holes offers (eb) the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics	
G_{24} : Category one of Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through well-established quantum mechanics black holes offers G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of potential to further explore (e&eb) the yet mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through well-established quantum mechanics black holes offers the potential to further explore (e&eb) the yet mysterious nature of quantum gravity through well-established quantum mechanics	
G_{28} : Category one of **Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through well-established quantum mechanics black holes offers the potential;** mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics G_{29} : Category two of SAS G_{30} : Category three of SAS	

T_{28} : Category one of mysterious nature of quantum gravity through (e&eb) well-established quantum mechanics **;Ability to simulate black holes offers the potential to further explore the yet mysterious nature of quantum gravity through well-established quantum mechanics black holes offers the potential** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six Quantum mechanics and (e&eb) gravity can seem to contradict each other	
G_{32} : Category one of **Quantum mechanics;** gravity G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of gravity **;Quantum mechanics** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven	
G_{36} : Category one of superstrings; **matter** G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of **matter;** superstrings T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight Superstring theory may provide a route to reconcile the two, thanks to (e) the gauge/gravity duality conjecture, which allows the system to be described mathematically	
G_{40} : Category one of **Superstring theory may provide a route to reconcile the two;** gauge/gravity duality conjecture, which allows (eb) the system to be described mathematically G_{41} : Category two of SAS G_{42} : Category three of SAS	

T_{40} : Category one of gauge/gravity duality conjecture, which allows (eb) the system to be described mathematically **;Superstring theory may provide a route to reconcile the two**

T_{41} : Category two of SAS

T_{42} : Category three of SAS

Module Nine

However, this conjecture has yet to be formally confirmed. Hanada et al. (see the Perspective by Maldacena) performed a simulation of (e&eb) the dual gauge theory in the parameter regime that corresponds to (e&eb) a quantum black hole. Their results agree with (eb) a prediction for an evaporating black hole, including (e) quantum gravity corrections, confirming that (eb) the dual gauge theory indeed provides (eb) a complete description of the quantum nature of (e) the evaporating black hole. Science, this issue p. 882; see also p. 806

G_{44} : Category one of **dual gauge theory;** quantum nature of the evaporating black hole

G_{45} : Category two of SAS

G_{46} : Category three of SAS

T_{44} : Category one of quantum nature of the evaporating black hole; **dual gauge theory**

T_{45} : Category two of SAS

T_{46} : Category three of SAS

The Coefficients:

$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$:
$(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$
$(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$,
$(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$
$(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$
$(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$
$(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$

are Accentuation coefficients
$(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$
, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$
$(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$,
$(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$
$(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$,
$(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$,
$(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$,
are Dissipation coefficients

Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\big((G_{19}),t\big)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\big((G_{19}),t\big)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\big((G_{19}),t\big)\right]T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\big((G_{19}),t\big) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a''_{20})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right]G_{24}$	19

$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)} (T_{25}, t) \right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)} (T_{25}, t) \right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)} \left((G_{27}), t \right) \right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)} \left((G_{27}), t \right) \right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)} \left((G_{27}), t \right) \right] T_{26}$	24
$+(a''_{24})^{(4)} (T_{25}, t) =$ First augmentation factor	
$-(b''_{24})^{(4)} \left((G_{27}), t \right) =$ First detritions factor	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)} (T_{29}, t) \right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)} (T_{29}, t) \right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)} (T_{29}, t) \right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)} \left((G_{31}), t \right) \right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)} \left((G_{31}), t \right) \right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)} \left((G_{31}), t \right) \right] T_{30}$	30
$+(a''_{28})^{(5)} (T_{29}, t) =$ First augmentation factor	
$-(b''_{28})^{(5)} \left((G_{31}), t \right) =$ First detritions factor	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)} (T_{33}, t) \right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)} (T_{33}, t) \right] G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)} (T_{33}, t) \right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)} \left((G_{35}), t \right) \right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)} \left((G_{35}), t \right) \right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)} \left((G_{35}), t \right) \right] T_{34}$	36
$+(a''_{32})^{(6)} (T_{33}, t) =$ First augmentation factor	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)} (T_{37}, t) \right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}, t) \right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}, t) \right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)} \left((G_{39}), t \right) \right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)} \left((G_{39}), t \right) \right] T_{37}$	*41*

$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	42
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right]G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right]G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41},t)\right]G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[\begin{matrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[\begin{matrix} (a_{14}^{'})^{(1)} \boxed{+(a_{14}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[\begin{matrix} (a_{15}^{'})^{(1)} \boxed{+(a_{15}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$	57
Where $\boxed{(a_{13}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{14}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{15}^{''})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3	

$+(a''_{24})^{(4,4,4,4,)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{38})^{(7,7)}(T_{37},t)$ $+(a''_{37})^{(7,7)}(T_{37},t)$ $+(a''_{36})^{(7,7)}(T_{37},t)$ are seventh augmentation coefficient for 1,2,3 $+(a''_{40})^{(8,8)}(T_{41},t)$ $+(a''_{41})^{(8,8)}(T_{41},t)$ $+(a''_{42})^{(8,8)}(T_{41},t)$ are eight augmentation coefficient for 1,2,3 $+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	*60*
Where $-(b''_{13})^{(1)}(G,t)$, $-(b''_{14})^{(1)}(G,t)$, $-(b''_{15})^{(1)}(G,t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{16})^{(2,2,)}(G_{19},t)$, $-(b''_{17})^{(2,2,)}(G_{19},t)$, $-(b''_{18})^{(2,2,)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3 $-(b''_{20})^{(3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{37})^{(7,7,)}(G_{39},t)$, $-(b''_{36})^{(7,7,)}(G_{39},t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8)}(G_{43},t)$ $-(b''_{41})^{(8,8)}(G_{43},t)$ $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a_{16}')^{(2)} \boxed{+(a_{16}'')^{(2)}(T_{17},t)} \boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a_{17}')^{(2)} \boxed{+(a_{17}'')^{(2)}(T_{17},t)} \boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a_{18}')^{(2)} \boxed{+(a_{18}'')^{(2)}(T_{17},t)} \boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)} \boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	63
Where $\boxed{+(a_{16}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{44}'')^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b_{16}')^{(2)} \boxed{-(b_{16}'')^{(2)}(G_{19},t)} \boxed{-(b_{13}'')^{(1,1,)}(G,t)} \boxed{-(b_{20}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b_{17}')^{(2)} \boxed{-(b_{17}'')^{(2)}(G_{19},t)} \boxed{-(b_{14}'')^{(1,1,)}(G,t)} \boxed{-(b_{21}'')^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}'')^{(7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17}$	65

$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3	

$+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3

$+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3

$+(a''_{40})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3

$+(a''_{44})^{(9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t) - (b''_{16})^{(2,2,2)}(G_{19},t) - (b''_{13})^{(1,1,1,)}(G,t) \\ -(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{28})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{32})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7,7)}(G_{39},t) - (b''_{40})^{(8,8,8,8)}(G_{43},t) - (b''_{44})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t) - (b''_{17})^{(2,2,2)}(G_{19},t) - (b''_{14})^{(1,1,1,)}(G,t) \\ -(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{29})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{33})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{37})^{(7,7,7,7)}(G_{39},t) - (b''_{41})^{(8,8,8,8)}(G_{43},t) - (b''_{45})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23},t) - (b''_{18})^{(2,2,2)}(G_{19},t) - (b''_{15})^{(1,1,1,)}(G,t) \\ -(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t) - (b''_{30})^{(5,5,5,5,5,5)}(G_{31},t) - (b''_{34})^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b''_{38})^{(7,7,7,7)}(G_{39},t) - (b''_{42})^{(8,8,8,8)}(G_{43},t) - (b''_{46})^{(9,9,9)}(G_{47},t) \end{bmatrix} T_{22} \quad 72$$

$-(b''_{20})^{(3)}(G_{23},t)$, $-(b''_{21})^{(3)}(G_{23},t)$, $-(b''_{22})^{(3)}(G_{23},t)$ *are first detrition coefficients for category 1, 2 and 3*

$-(b''_{16})^{(2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2)}(G_{19},t)$ *are second detrition coefficients for category 1, 2 and 3*

$-(b''_{13})^{(1,1,1,)}(G,t)$, $-(b''_{14})^{(1,1,1,)}(G,t)$, $-(b''_{15})^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3*

$-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3*

$-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3*

$-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3*

$-(b''_{36})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3

$-(b''_{40})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[\begin{matrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{24} \tag{73}$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[\begin{matrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{25} \tag{74}$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[\begin{matrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{26} \tag{75}$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$
are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$
are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$
are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$
are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$
are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[\begin{matrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{24} \tag{76}$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[\begin{matrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{25} \tag{77}$$

$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3	

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8\,,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28} \quad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30} \quad 84$$

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$	*85*
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$	*86*
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$	*87*
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32}$	*88*

$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$	89
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)}\boxed{+(a''_{38})^{(7)}(T_{37},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \qquad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)}\boxed{-(b''_{36})^{(7)}(G_{39},t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \qquad 94$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)}\boxed{-(b''_{37})^{(7)}(G_{39},t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)}\boxed{-(b''_{38})^{(7)}(G_{39},t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{13}$	95
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second	

augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[\begin{matrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13}$$ 96

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b_{44}')^{(9)}\boxed{-(b_{44}'')^{(9)}(G_{47},t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$	
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b_{45}')^{(9)}\boxed{-(b_{45}'')^{(9)}(G_{47},t)} \boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$	
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}')^{(9)}\boxed{-(b_{46}'')^{(9)}(G_{47},t)} \boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$	
Where $\boxed{-(b_{44}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3	

$-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)},(a'_i)^{(1)},(a''_i)^{(1)},(b_i)^{(1)},(b'_i)^{(1)},(b''_i)^{(1)}>0, \quad i,j=13,14,15$ The functions $(a''_i)^{(1)},(b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t)\le(p_i)^{(1)}\le(\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t)\le \ (r_i)^{(1)}\le(b'_i)^{(1)}\le(\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t)=(p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t)= \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}$ are positive constants and $i=13,14,15$	98
They satisfy Lipschitz condition: $\vert(a''_i)^{(1)}(T'_{14},t)-(a''_i)^{(1)}(T_{14},t)\vert\le(\hat{k}_{13})^{(1)}\vert T_{14}-T'_{14}\vert e^{-(\hat{M}_{13})^{(1)}t}$ $\vert(b''_i)^{(1)}(G',t)-(b''_i)^{(1)}(G,t)\vert<(\hat{k}_{13})^{(1)}\vert\vert G-G'\vert\vert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a''_i)^{(1)}(T'_{14},t)$ and $(a''_i)^{(1)}(T_{14},t)$. (T'_{14},t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a''_i)^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a''_i)^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a'_i)^{(1)},(b_i)^{(1)},(b'_i)^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}, i=13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i^{'})^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i^{'})^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	
Where we suppose	
$(a_i)^{(2)}, (a_i^{'})^{(2)}, (a_i^{''})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (b_i^{''})^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i^{''})^{(2)}, (b_i^{''})^{(2)}$ are positive continuous increasing and bounded.	
<u>Definition of</u> $(\mathrm{p_i})^{(2)}, \ (\mathrm{r_i})^{(2)}$:	
$(a_i^{''})^{(2)}(T_{17}, t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19}, t) \leq (r_i)^{(2)} \leq (b_i^{'})^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty} (a_i^{''})^{(2)}(T_{17}, t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty} (b_i^{''})^{(2)}\left((G_{19}), t\right) = (r_i)^{(2)}$	105
<u>Definition of</u> $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}}$ are positive constants and $\boxed{i = 16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(2)}(T_{17}^{'}, t) - (a_i^{''})^{(2)}(T_{17}, t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}^{'}\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i^{''})^{(2)}((G_{19})', t) - (b_i^{''})^{(2)}\left((G_{19}), t\right)\rvert < (\hat{k}_{16})^{(2)} \lvert\lvert(G_{19}) - (G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(2)}(T_{17}^{'}, t)$ and $(a_i^{''})^{(2)}(T_{17}, t)$. $(T_{17}^{'}, t)$ and (T_{17}, t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i^{''})^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i^{''})^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} \ , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
<u>Definition of</u> $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and \ (\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i')^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\,(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i')^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i, j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty}(a_i'')^{(3)}\,(T_{21}, t) = (p_i)^{(3)}$ $\lim_{\mathrm{G} \to \infty}(b_i'')^{(3)}\,(G_{23}, t) = \ (r_i)^{(3)}$ **<u>Definition of</u>** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20,21,22}$	113
They satisfy Lipschitz condition: $\lvert(a_i'')^{(3)}(T_{21}', t) - (a_i'')^{(3)}(T_{21}, t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i'')^{(3)}(G_{23}', t) - (b_i'')^{(3)}(G_{23}, t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
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<u>Definition of</u> $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)},$ are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} \ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
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They satisfy Lipschitz condition: $\|(a_i'')^{(4)}(T_{25}',t) - (a_i'')^{(4)}(T_{25},t)\| \leq (\hat{k}_{24})^{(4)}\|T_{25} - T_{25}'\|e^{-(\hat{M}_{24})^{(4)}t}$ $\|(b_i'')^{(4)}((G_{27})',t) - (b_i'')^{(4)}((G_{27}),t)\| < (\hat{k}_{24})^{(4)}\|\|(G_{27}) - (G_{27})'\|\|e^{-(\hat{M}_{24})^{(4)}t}$	119
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<u>**Definition of**</u> $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}, \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

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Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

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Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)}$ *and* $(\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t) \le (p_i)^{(6)} \le (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t) \le (r_i)^{(6)} \le (b_i')^{(6)} \le (\hat{B}_{32})^{(6)}$	127
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They satisfy Lipschitz condition: $\|(a_i^{''})^{(7)}(T_{37}^{'},t) - (a_i^{''})^{(7)}(T_{37},t)\| \leq (\hat{k}_{36})^{(7)}\|T_{37} - T_{37}^{'}\|e^{-(\hat{M}_{36})^{(7)}t}$ $\|(b_i^{''})^{(7)}((G_{39})^{'},t) - (b_i^{''})^{(7)}((G_{39}),t)\| < (\hat{k}_{36})^{(7)}\|\|(G_{39}) - (G_{39})^{'}\|\|e^{-(\hat{M}_{36})^{(7)}t}$	133
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system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (WWWWWWW) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
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They satisfy Lipschitz condition:	
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Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
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Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t)\le(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0)=G_i^0>0$	149

$T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44}\right)^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$,$T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$,$T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right), s_{(16)}\right)\right) G_{18}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{16}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}\left(s_{(16)}\right) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{17}\left(s_{(16)}\right)\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right), s_{(16)}\right)\right) T_{18}\left(s_{(16)}\right)\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{20})^{(3)}$, $T_i^0 \leq (\hat{Q}_{20})^{(3)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{20}\left(s_{(20)}\right)\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}\left(s_{(20)}\right) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{21}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{22}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{20}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}\left(s_{(20)}\right) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{21}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{22}\left(s_{(20)}\right)\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\hat{P}_{32})^{(6)} \,, T_i^0 \leq (\hat{Q}_{32})^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\hat{P}_{36})^{(7)} \,, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
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<u>Remark 26:</u> The fact that we supposed $(a_{32}^{''})^{(6)}$ and $(b_{32}^{''})^{(6)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{32})^{(6)}e^{(\widehat{M}_{32})^{(6)}t}$ *and* $(\widehat{Q}_{32})^{(6)}e^{(\widehat{M}_{32})^{(6)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(6)}$ and $(b_i^{''})^{(6)}, i=32,33,34$ depend only on T_{33} and respectively on $(G_{35})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	249
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Indeed let t_6 be so that for $t > t_6$ $(b_{33})^{(6)} - (b_i'')^{(6)}\big((G_{35})(t),t\big) < \varepsilon_6, T_{32}\,(t) > (m)^{(6)}$	
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Definition of $\left((\widehat{M}_{36})^{(7)}\right)_1,\left((\widehat{M}_{36})^{(7)}\right)_2$ *and* $\left((\widehat{M}_{36})^{(7)}\right)_3$: **Remark 33:** if G_{36} is bounded, the same property have also G_{37} *and* G_{38} . indeed if $G_{36}<(\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt}\leq\left((\widehat{M}_{36})^{(7)}\right)_1-(a_{37}')^{(7)}G_{37}$ and by integrating $G_{37}\leq\left((\widehat{M}_{36})^{(7)}\right)_2=G_{37}^0+2(a_{37})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_1/(a_{37}')^{(7)}$ In the same way , one can obtain $G_{38}\leq\left((\widehat{M}_{36})^{(7)}\right)_3=G_{38}^0+2(a_{38})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_2/(a_{38}')^{(7)}$ If G_{37} *or* G_{38} is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.	262
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Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(7)}((G_{39})(t),t)) = (b_{37}')^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i'')^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$	264
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It is now sufficient to take $\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$ and to choose $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ large to have	266
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
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In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **Definition of** $\widetilde{(G_{43})}, \widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results	271

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Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,t]$ From the hypotheses it follows	272
$\left\|(G_{43})^{(1)}-(G_{43})^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} t} \leq$ $\frac{1}{(\widehat{M}_{40})^{(8)}}\left((a_{40})^{(8)} + (a_{40}')^{(8)} + (\widehat{A}_{40})^{(8)} + (\widehat{P}_{40})^{(8)} (\widehat{k}_{40})^{(8)}\right) d\left(\left((G_{43})^{(1)}, (T_{43})^{(1)}; (G_{43})^{(2)}, (T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
Remark 36: The fact that we supposed $(a_{40}'')^{(8)}$ and $(b_{40}'')^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)} e^{(\widehat{M}_{40})^{(8)} t}$ *and* $(\widehat{Q}_{40})^{(8)} e^{(\widehat{M}_{40})^{(8)} t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on (G_{43})*(and not on t)* and hypothesis can replaced by a usual Lipschitz condition.	274
Remark 37 There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)} - (a_i'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)} t)} > 0 \;$ for $t > 0$	275
Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1 / (a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2 / (a_{42}')^{(8)}$	276

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$	278
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It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) = \sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})}, \widetilde{(T_{47})} : \big(\widetilde{(G_{47})}, \widetilde{(T_{47})}\big) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$\left|\tilde{G}_{44}^{(1)}-\tilde{G}_{i}^{(2)}\right| \leq \int_0^t (a_{44})^{(9)} \left|G_{45}^{(1)}-G_{45}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}}\, ds_{(44)} +$
$\int_0^t \{(a_{44}^{'})^{(9)} \left|G_{44}^{(1)}-G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$(a_{44}^{''})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)}-G_{44}^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)}\left|(a_{44}^{''})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)-(a_{44}^{''})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)\right|\; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}}\} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$\left|(G_{47})^{(1)}-G^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} t} \leq$
$\frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)}+\ (a_{44}^{'})^{(9)}+(\widehat{A}_{44})^{(9)}+(\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right) d\left(\left((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)}\right)\right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

<u>**Remark 41:**</u> The fact that we supposed $(a_{44}^{''})^{(9)}$ and $(b_{44}^{''})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i=44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

<u>**Remark 42:**</u> There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)}-(a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(9)} t\right)} > 0 \quad \text{for } t>0$$

<u>**Definition of**</u> $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

<u>**Remark 43:**</u> if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

<u>**Remark 44:**</u> If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t),t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1-e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t),t) = (b_{46}')^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14},t) + (a_{14}'')^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b_{13}')^{(1)} + (b_{14}')^{(1)} - (b_{13}'')^{(1)}(G,t) - (b_{14}'')^{(1)}(G,t) \leq -(\tau_1)^{(1)}$

Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: 281

By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: 282

By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- 283

If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by
$(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if \ (\nu_0)^{(1)} < (\nu_1)^{(1)}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$

and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}\ ,if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq$ $\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}] + G_{15}^0 e^{-(a_{15}')^{(1)}t})$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
<u>**Definition of**</u> $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
<u>**Behavior of the solutions of equation**</u>	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}), t\right) - (b_{17}^{''})^{(2)}\left((G_{19}), t\right) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}$, ***if*** $(\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}$, ***if*** $(\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}$, ***if*** $(\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}$, ***if*** $(u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}$, ***if*** $(u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}$, ***if*** $(\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^{0} e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^{0} e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^{0} e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^{0} e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^{0}}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^{0} e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^{0} e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^{0} e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^{0}}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^{0} e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^{0}}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^{0} e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}\left((G_{23}), t\right) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
<u>**Definition of**</u> $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}\ ,\boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ ,\boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}^{'})^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}^{'})^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}^{'})^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}^{'})^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}^{'})^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}^{'})^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \le -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \le -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \le -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \le -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)},\ \boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)},\ \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \textbf{if } (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b'_{26})^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b'_{26})^{(4)}t}\right] + T_{26}^0 e^{-(b'_{26})^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a'_{24})^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b'_{24})^{(4)}$ $(R_2)^{(4)} = (b'_{26})^{(4)} - (r_{26})^{(4)}$	337
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By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}, \ \boldsymbol{if}\ (\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}, \boldsymbol{if}\ (\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
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Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b_{30}')^{(5)}t}\right]+T_{30}^0e^{-(b_{30}')^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0e^{-(R_2)^{(5)}t}$	347
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and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
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$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
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Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} - (a_{36}^{''})^{(7)}(T_{37}, t) + (a_{37}^{''})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (b_{36}^{''})^{(7)}\big((G_{39}), t\big) - (b_{37}^{''})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)},\ \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
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where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a'_{38})^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a'_{38})^{(7)}t}] + G_{38}^0 e^{-(a'_{38})^{(7)}t})$	366
$T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b'_{38})^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b'_{38})^{(7)}t}\right] + T_{38}^0 e^{-(b'_{38})^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
<u>**Definition of**</u> $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a'_{36})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$ $(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$	370
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}((G_{43}), t) - (b''_{41})^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
<u>**Definition of**</u> $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}(\nu^{(8)})^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, $\boldsymbol{if}$ $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}$ $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}$ $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}\left((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)}\right)}\left[e^{\left((S_1)^{(8)} - (p_{40})^{(8)}\right)t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}\left((S_1)^{(8)} - (a_{42}')^{(8)}\right)}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a_{44}')^{(9)} + (a_{45}')^{(9)} - (a_{44}'')^{(9)}(T_{45}, t) + (a_{45}'')^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b_{44}')^{(9)} + (b_{45}')^{(9)} - (b_{44}'')^{(9)}((G_{47}), t) - (b_{45}'')^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},$ ***if*** $(\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, ***if*** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$, and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, ***if*** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$	
and analogously $(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, ***if*** $(u_0)^{(9)} < (u_1)^{(9)}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, ***if*** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$, and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, ***if*** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively	
Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities $G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$ where $(p_i)^{(9)}$ is defined by equation 45	
$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$	
$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$ $\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \Big)$	
$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$ $\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
<u>Definition of</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$ $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$ $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$	

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right) - (a''_{14})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \le \frac{d\nu^{(1)}}{dt} \le -\left((a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \ge \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \le \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \le \nu^{(1)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \le (\bar{\nu}_1)^{(1)} \le \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \le \nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)} G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)} T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}')^{(3)} - (a_{21}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right) - (a_{21}'')^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case** .

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)},\quad\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)},\quad\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \le \nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$$(m_2)^{(6)} \le \nu^{(6)}(t) \le (m_1)^{(6)}, \quad \boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)} \le u^{(6)}(t) \le (\mu_1)^{(6)}, \quad \boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \le \frac{d\nu^{(7)}}{dt} \le -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G^0_{36}}{G^0_{37}}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \ge \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \le \nu^{(7)}(t) \le (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **<u>Definition of</u>** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
<u>Definition of</u> $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **<u>Particular case :</u>** If $(a_{36}^{''})^{(7)} = (a_{37}^{''})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b_{36}^{''})^{(7)} = (b_{37}^{''})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

Proof : From 99,20,44,22,23,44 we obtain 424A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ *with* $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ *with* $(p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ *with* $(p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ *with* $(p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b'_{44})^{(9)}(r_{45})^{(9)} - (b'_{45})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\,]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (dd) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T^*_{17} for which $f(T^*_{17}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	495
Definition and uniqueness of T^*_{21} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T^*_{21} for which $f(T^*_{21}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$	496
Definition and uniqueness of T^*_{25} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T^*_{25} for which $f(T^*_{25}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a'_{24})^{(4)}+(a''_{24})^{(4)}(T^*_{25})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a'_{26})^{(4)}+(a''_{26})^{(4)}(T^*_{25})]}$	497
Definition and uniqueness of T^*_{29} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T^*_{29} for which $f(T^*_{29}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a'_{28})^{(5)}+(a''_{28})^{(5)}(T^*_{29})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a'_{30})^{(5)}+(a''_{30})^{(5)}(T^*_{29})]}$	498
Definition and uniqueness of T^*_{33} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T^*_{33} for which $f(T^*_{33}) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	
Definition and uniqueness of T_{37}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$	500
Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right]+(b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right]+(b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27}) + (b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right] + (b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31}) + (b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right] + (b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35}) + (b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right] + (b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39}) + (b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right] + (b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b_{40}^{'})^{(8)}(b_{41}^{''})^{(8)}(G_{43}) + (b_{41}^{'})^{(8)}(b_{40}^{''})^{(8)}(G_{43})\right] + (b_{40}^{''})^{(8)}(G_{43})(b_{41}^{''})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^{*} such that $\varphi(G_{43}{}^{*}) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - \left[(b_{44}^{'})^{(9)}(b_{45}^{''})^{(9)}(G_{47}) + (b_{45}^{'})^{(9)}(b_{44}^{''})^{(9)}(G_{47})\right] + (b_{44}^{''})^{(9)}(G_{47})(b_{45}^{''})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^{*} such that $\varphi((G_{47})^{*}) = 0$	
Finally we obtain the unique solution G_{14}^{*} given by $\varphi(G^{*}) = 0$, T_{14}^{*} given by $f(T_{14}^{*}) = 0$ and $G_{13}^{*} = \frac{(a_{13})^{(1)}G_{14}^{*}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^{*})]}$, $G_{15}^{*} = \frac{(a_{15})^{(1)}G_{14}^{*}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^{*})]}$ $T_{13}^{*} = \frac{(b_{13})^{(1)}T_{14}^{*}}{[(b_{13}^{'})^{(1)}-(b_{13}^{''})^{(1)}(G^{*})]}$, $T_{15}^{*} = \frac{(b_{15})^{(1)}T_{14}^{*}}{[(b_{15}^{'})^{(1)}-(b_{15}^{''})^{(1)}(G^{*})]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^{*} given by $\varphi((G_{19})^{*}) = 0$, T_{17}^{*} given by $f(T_{17}^{*}) = 0$ and	512
$G_{16}^{*} = \frac{(a_{16})^{(2)}G_{17}^{*}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18}^{*} = \frac{(a_{18})^{(2)}G_{17}^{*}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^{*})]}$	513
$T_{16}^{*} = \frac{(b_{16})^{(2)}T_{17}^{*}}{[(b_{16}^{'})^{(2)}-(b_{16}^{''})^{(2)}((G_{19})^{*})]}$, $T_{18}^{*} = \frac{(b_{18})^{(2)}T_{17}^{*}}{[(b_{18}^{'})^{(2)}-(b_{18}^{''})^{(2)}((G_{19})^{*})]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^{*} given by $\varphi((G_{23})^{*}) = 0$, T_{21}^{*} given by $f(T_{21}^{*}) = 0$ and $G_{20}^{*} = \frac{(a_{20})^{(3)}G_{21}^{*}}{[(a_{20}^{'})^{(3)}+(a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22}^{*} = \frac{(a_{22})^{(3)}G_{21}^{*}}{[(a_{22}^{'})^{(3)}+(a_{22}^{''})^{(3)}(T_{21}^{*})]}$ $T_{20}^{*} = \frac{(b_{20})^{(3)}T_{21}^{*}}{[(b_{20}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23}{}^{*})]}$, $T_{22}^{*} = \frac{(b_{22})^{(3)}T_{21}^{*}}{[(b_{22}^{'})^{(3)}-(b_{22}^{''})^{(3)}(G_{23}{}^{*})]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -((a_{13}^{'})^{(1)} + (p_{13})^{(1)})\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -((a_{14}^{'})^{(1)} + (p_{14})^{(1)})\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -((a_{15}^{'})^{(1)} + (p_{15})^{(1)})\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -((b_{13}^{'})^{(1)} - (r_{13})^{(1)})\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(13)(j)} T_{13}^* \mathbb{G}_j)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -((b_{14}^{'})^{(1)} - (r_{14})^{(1)})\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}(s_{(14)(j)} T_{14}^* \mathbb{G}_j)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -((b_{15}^{'})^{(1)} - (r_{15})^{(1)})\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(15)(j)} T_{15}^* \mathbb{G}_j)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial \mathbb{T}_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b'_{20})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b'_{21})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b'_{22})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(4)}$ *and* $(b''_i)^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b''_i)^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*}) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}\left(\left(G_{35}\right)^{*}\right) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j} ((G_{39})^{**}) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G_{36}^* \mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G_{37}^* \mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G_{38}^* \mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T_{36}^* \mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T_{37}^* \mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T_{38}^* \mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ and $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}} (T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j} ((G_{43})^{*}) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G_{40}^* \mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G_{41}^* \mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_{+})$ then the above equilibrium point is asymptotically stable. **Proof: Denote**	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$

$+\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$ +	
$\left((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$\left((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$	

$$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$$

$+$

$$((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)})\{((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)})$$

$$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$$

$+$

$$((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)})\{((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)})$$

$$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)}+(a_{45}')^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION THIRTY ONE

Matrix Perturbation Theory For M-Theory

INTRODUCTION—VARIABLES USED

Matrix perturbation theory for M-theory on a PP-wave Keshav Dasgupta1, Mohammad M. Sheikh-Jabbari1 and Mark Van Raamsdonk1 Published 25 June 2002 • Journal of High Energy Physics, Volume 2002, JHEP05(2002)

(1) In this paper, authors study the matrix model proposed by Berenstein, Maldacena, and Nastase to describe (eb) M-theory on the maximally supersymmetric pp-wave.
(2) They show that the model may be derived directly as (=) a discretized theory of supermembranes in (eb) the pp-wave background, or alternatively, from (e) the dynamics of D0-branes in (eb) type-IIA string theory.
(3) Authors consider expanding the model about each of its classical supersymmetric vacua and note that for large values of the mass parameter μ, interaction terms are suppressed by (e) powers of μ−1, so that the model may be studied in perturbation theory.

(4) They compute the exact spectrum about (e&eb) each of the vacua in the large-μ limit and find (eb) the complete (infinite) set of BPS states, which includes (e) states preserving 2, 4, 6, 8, or 16 supercharges

(5) Through explicit perturbative calculations, we then determine (eb) the effective coupling that controls (e&eb) the perturbation expansion for large μ and estimate the range of parameters and (e&eb) energies for which perturbation theory is valid.

Monte Carlo Studies of Supersymmetric Matrix Quantum Mechanics with Sixteen Supercharges at Finite Temperature Konstantinos N. Anagnostopoulos, Masanori Hanada, Jun Nishimura, and Shingo Takeuchi Phys. Rev. Lett. 100, 021601 – Published 15 January 2008

(6) Authors present the first Monte Carlo results for (e) supersymmetric matrix quantum mechanics with (e&eb) 16 supercharges at finite temperature.

(7) The recently proposed nonlattice simulation enables (eb) to include (e) the effects of (e&eb) fermionic matrices in a transparent and reliable manner.

(8) The internal energy nicely interpolates (e&eb) the weak coupling behavior obtained by (e) the high temperature expansion, and (e&eb) the strong coupling behavior predicted from (e) the dual black-hole geometry.

(9) The Polyakov line asymptotes at low temperature to a (e&eb) characteristic behavior for a deconfined theory, suggesting (eb) the absence of a phase transition.

(10) These results provide (eb) highly nontrivial evidence for the gauge-gravity duality. Received 4 September 2007DOI:http://dx.doi.org/10.1103/PhysRevLett.100.021601

NOTATION

Module One

In this paper, authors study the **matrix model proposed by Berenstein, Maldacena, and Nastase** to describe (eb) M-theory on the maximally supersymmetric pp-wave

G_{13} : Category one of **matrix model proposed by Berenstein, Maldacena, and Nastase;** M-theory on the maximally supersymmetric pp-wave

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of M-theory on the maximally supersymmetric pp-wave; **matrix model proposed by Berenstein, Maldacena, and Nastase**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

They show that the model may be derived directly as (=) a discretized theory of supermembranes in (eb) the pp-wave background, or alternatively, from (e) the dynamics of D0-branes in (eb) type-IIA string theory.

G_{16} : Category one of model may be derived directly

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of discretized theory of supermembranes in (eb) the pp-wave background, or alternatively, from (e) the dynamics of D0-branes in (eb) type-IIA string theory. T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three They show that the model may be derived directly as a discretized theory of supermembranes in (eb) the pp-wave background, or alternatively, from (e) the dynamics of D0-branes in (eb) type-IIA string theory	
G_{20} : Category one of **discretized theory of supermembranes;** pp-wave background, or alternatively, from (e) the dynamics of D0-branes in (eb) type-IIA string theory G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of pp-wave background, or alternatively, from (e) the dynamics of D0-branes in (eb) type-IIA string theory **;discretized theory of supermembranes** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four They show that the model may be derived directly as a discretized theory of supermembranes in the pp-wave background, or alternatively, from (e) the dynamics of D0-branes in (eb) type-IIA string theory	
G_{24} : Category one of dynamics of D0-branes in type-IIA string theory G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of model may be derived directly as a discretized theory of supermembranes in the pp-wave background, or alternatively T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Authors consider expanding the model about each of its classical supersymmetric vacua and note that for large values of the mass parameter μ, interaction terms are suppressed by (e) powers of μ−1, so that the model may be studied in perturbation theory	
G_{28} : Category one of **model about each of its classical supersymmetric vacua and note that for large values of the mass parameter μ, interaction terms;** powers of μ−1, so that the model may be studied in perturbation theory G_{29} : Category two of SAS	

G_{30} : Category three of SAS	
T_{28} : Category one of powers of μ−1, so that the model may be studied in perturbation theory **;model about each of its classical supersymmetric vacua and note that for large values of the mass parameter μ, interaction terms** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six They compute the exact spectrum about (e&eb) each of the vacua in the large-μ limit and find (eb) the complete (infinite) set of BPS states, which includes (e) states preserving 2, 4, 6, 8, or 16 supercharges	
G_{32} : Category one of **exact spectrum;** each of the vacua in the large-μ limit and find (eb) the complete (infinite) set of BPS states, which includes (e) states preserving 2, 4, 6, 8, or 16 supercharges G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of each of the vacua in the large-μ limit and find (eb) the complete (infinite) set of BPS states, which includes (e) states preserving 2, 4, 6, 8, or 16 supercharges **;exact spectrum** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven They compute the exact spectrum about each of the vacua in the large-μ limit and find (eb) the complete (infinite) set of BPS states, which includes (e) states preserving 2, 4, 6, 8, or 16 supercharges	
G_{36} : Category one of exact spectrum about each of the vacua in the large-μ limit G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of complete (infinite) set of BPS states, which includes (e) states preserving 2, 4, 6, 8, or 16 supercharges T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight They compute the **exact spectrum about each of the vacua in the large-μ limit and find the complete (infinite) set of BPS states**, which includes (e) states preserving 2, 4, 6, 8, or 16 supercharges	

G_{40} : Category one of **exact spectrum about each of the vacua in the large-μ limit and find the complete (infinite) set of BPS states;** states preserving 2, 4, 6, 8, or 16 supercharges G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of states preserving 2, 4, 6, 8, or 16 supercharges; **exact spectrum about each of the vacua in the large-μ limit and find the complete (infinite) set of BPS states** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine Through explicit perturbative calculations, authors then determine (eb) the effective coupling that controls (e&eb) the perturbation expansion for large μ and estimate the range of parameters and (e&eb) energies for which perturbation theory is valid	
G_{44} : Category one of perturbative calculations G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of effective coupling that controls (e&eb) the perturbation expansion for large μ and estimate the range of parameters and (e&eb) energies for which perturbation theory is valid T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$,	

$(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a''_{20})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four	

The differential system of this model is now (Module numbered Four)	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}')^{(4)} + (a_{25}'')^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}')^{(4)} - (b_{24}'')^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}')^{(4)} - (b_{25}'')^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}')^{(4)} - (b_{26}'')^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}'')^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}')^{(5)} - (b_{28}'')^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}')^{(5)} - (b_{29}'')^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}')^{(5)} - (b_{30}'')^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}'')^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}'')^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}')^{(6)} - (b_{32}'')^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}')^{(6)} - (b_{33}'')^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}')^{(6)} - (b_{34}'')^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}'')^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37},t)\right]G_{38}$	*39*

$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)} \left((G_{39}), t \right) \right] T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)} \left((G_{39}), t \right) \right] T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)} \left((G_{39}), t \right) \right] T_{38}$	42
$+(a''_{36})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41}, t) \right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}, t) \right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)} \left((G_{43}), t \right) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)} \left((G_{43}), t \right) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)} \left((G_{43}), t \right) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)} \left((G_{47}), t \right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)} \left((G_{47}), t \right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)} \left((G_{47}), t \right) \right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}), t \right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14}, t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{40})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14}, t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{41})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14}, t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17}, t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37}, t)} \boxed{+(a''_{42})^{(8,8)}(T_{41}, t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14}, t)}$, $\boxed{(a''_{14})^{(1)}(T_{14}, t)}$, $\boxed{(a''_{15})^{(1)}(T_{14}, t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17}, t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17}, t)}$ are second augmentation coefficient for	

category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \quad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14} \quad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15} \quad 60$$

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{16}$	64

$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\begin{bmatrix}(b_{17}^{'})^{(2)}\boxed{-(b_{17}^{''})^{(2)}(G_{19},t)}\boxed{-(b_{14}^{''})^{(1,1,)}(G,t)}\boxed{-(b_{21}^{''})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b_{29}^{''})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b_{33}^{''})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b_{37}^{''})^{(7,7,7)}(G_{39},t)}\boxed{-(b_{41}^{''})^{(8,8,8)}(G_{43},t)}\boxed{-(b_{45}^{''})^{(9,9)}(G_{47},t)}\end{bmatrix}T_{17}$	65
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\begin{bmatrix}(b_{18}^{'})^{(2)}\boxed{-(b_{18}^{''})^{(2)}(G_{19},t)}\boxed{-(b_{15}^{''})^{(1,1,)}(G,t)}\boxed{-(b_{22}^{''})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b_{30}^{''})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b_{34}^{''})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b_{38}^{''})^{(7,7,7)}(G_{39},t)}\boxed{-(b_{42}^{''})^{(8,8,8)}(G_{43},t)}\boxed{-(b_{46}^{''})^{(9,9)}(G_{47},t)}\end{bmatrix}T_{18}$	66
where $\boxed{-(b_{16}^{''})^{(2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{13}^{''})^{(1,1,)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b_{36}^{''})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b_{40}^{''})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}^{''})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b_{44}^{''})^{(9,9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\begin{bmatrix}(a_{20}^{'})^{(3)}\boxed{+(a_{20}^{''})^{(3)}(T_{21},t)}\boxed{+(a_{16}^{''})^{(2,2,2)}(T_{17},t)}\boxed{+(a_{13}^{''})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{36}^{''})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a_{40}^{''})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a_{44}^{''})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{20}$	67
$\frac{dG_{21}}{dt}=(a_{21})^{(3)}G_{20}-\begin{bmatrix}(a_{21}^{'})^{(3)}\boxed{+(a_{21}^{''})^{(3)}(T_{21},t)}\boxed{+(a_{17}^{''})^{(2,2,2)}(T_{17},t)}\boxed{+(a_{14}^{''})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{37}^{''})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a_{41}^{''})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a_{45}^{''})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{21}$	68
$\frac{dG_{22}}{dt}=(a_{22})^{(3)}G_{21}-\begin{bmatrix}(a_{22}^{'})^{(3)}\boxed{+(a_{22}^{''})^{(3)}(T_{21},t)}\boxed{+(a_{18}^{''})^{(2,2,2)}(T_{17},t)}\boxed{+(a_{15}^{''})^{(1,1,1,)}(T_{14},t)}\\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{38}^{''})^{(7,7,7,7)}(T_{37},t)}\boxed{+(a_{42}^{''})^{(8,8,8,8)}(T_{41},t)}\boxed{+(a_{46}^{''})^{(9,9,9)}(T_{45},t)}\end{bmatrix}G_{22}$	69
$\boxed{+(a_{20}^{''})^{(3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{36}^{''})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b_{38}^{''})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{40}^{''})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}^{''})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{46}^{''})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}^{''})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a_{24}^{'})^{(4)} \boxed{+(a_{24}^{''})^{(4)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}^{''})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a_{25}^{'})^{(4)} \boxed{+(a_{25}^{''})^{(4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6)}(T_{33},t)} \\ \boxed{+(a_{14}^{''})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}^{''})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a_{26}^{'})^{(4)} \boxed{+(a_{26}^{''})^{(4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}^{''})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}^{''})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a_{24}^{''})^{(4)}(T_{25},t)}$, $\boxed{(a_{25}^{''})^{(4)}(T_{25},t)}$, $\boxed{(a_{26}^{''})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a_{28}^{''})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a_{32}^{''})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a_{13}^{''})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{16}^{''})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{20}^{''})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{36}^{''})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}^{''})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}^{''})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{40}^{''})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{46}^{''})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}^{''})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b_{24}^{'})^{(4)} \boxed{-(b_{24}^{''})^{(4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1)}(G,t)} \boxed{-(b_{16}^{''})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}^{''})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}^{''})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[\begin{matrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{25}$	77
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[\begin{matrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{26}$	78
Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[\begin{matrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation*	

coefficient for category 1, 2 *and* 3

$\boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b_{28}')^{(5)} \boxed{-(b_{28}'')^{(5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{32}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28} \quad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b_{29}')^{(5)} \boxed{-(b_{29}'')^{(5)}(G_{31},t)} \boxed{-(b_{25}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{33}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1)}(G,t)} \boxed{-(b_{17}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b_{30}')^{(5)} \boxed{-(b_{30}'')^{(5)}(G_{31},t)} \boxed{-(b_{26}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{34}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,)}(G,t)} \boxed{-(b_{18}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30} \quad 84$$

where $\boxed{-(b_{28}'')^{(5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{24}'')^{(4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b_{32}'')^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b_{13}'')^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b_{36}'')^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition

coefficients for category 1,2, and 3

$-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1,2, and 3

$-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t) + (a''_{28})^{(5,5,5)}(T_{29},t) + (a''_{24})^{(4,4,4,)}(T_{25},t) \\ +(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t) + (a''_{16})^{(2,2,2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t) + (a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{32} \quad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t) + (a''_{29})^{(5,5,5)}(T_{29},t) + (a''_{25})^{(4,4,4,)}(T_{25},t) \\ +(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t) + (a''_{17})^{(2,2,2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t) + (a''_{30})^{(5,5,5)}(T_{29},t) + (a''_{26})^{(4,4,4,)}(T_{25},t) \\ +(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t) + (a''_{18})^{(2,2,2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{34} \quad 87$$

$+(a''_{32})^{(6)}(T_{33},t)$, $+(a''_{33})^{(6)}(T_{33},t)$, $+(a''_{34})^{(6)}(T_{33},t)$ *are first augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{28})^{(5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5)}(T_{29},t)$ *are second augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{24})^{(4,4,4,)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,)}(T_{25},t)$ *are third augmentation coefficients for category* 1, 2 *and* 3

$+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)$ - are fourth augmentation coefficients

$+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)$ - fifth augmentation coefficients

$+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)$ sixth augmentation coefficients

$+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)$

seventh augmentation coefficients

$+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)$

Eighth augmentation coefficients

$+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35},t) - (b''_{28})^{(5,5,5)}(G_{31},t) - (b''_{24})^{(4,4,4,)}(G_{27},t) \\ -(b''_{13})^{(1,1,1,1,1,1)}(G,t) - (b''_{16})^{(2,2,2,2,2,2)}(G_{19},t) - (b''_{20})^{(3,3,3,3,3,3)}(G_{23},t) \\ -(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t) - (b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t) - (b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$$	89
$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$	91
$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$	92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \qquad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \qquad 94$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix}(a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{13}$	95
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix}(a'_{41})^{(8)}\boxed{+(a''_{41})^{(8)}(T_{41},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix}(a'_{42})^{(8)}\boxed{+(a''_{42})^{(8)}(T_{41},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second	

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)}\boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)}\boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)}\boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{matrix} (b'_{44})^{(9)}\boxed{-(b''_{44})^{(9)}(G_{47},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{13}$	
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{matrix} (b'_{45})^{(9)}\boxed{-(b''_{45})^{(9)}(G_{47},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{14}$	
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b'_{46})^{(9)}\boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix}\right] T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3	

$-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)},(a_i')^{(1)},(a_i'')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(b_i'')^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i'')^{(1)},(b_i'')^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i'')^{(1)}(T_{14},t) \le (p_i)^{(1)} \le (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \le \ (r_i)^{(1)} \le (b_i')^{(1)} \le (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b_i'')^{(1)}(G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \le (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \ , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities

$$\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$$

$$\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$$

Where we suppose

$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i, j = 16,17,18$

The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:

$(a_i'')^{(2)}(T_{17}, t) \le (p_i)^{(2)} \le (\hat{A}_{16})^{(2)}$ 102

$(b_i'')^{(2)}(G_{19}, t) \le (r_i)^{(2)} \le (b_i')^{(2)} \le (\hat{B}_{16})^{(2)}$ 103

$\lim_{T_2 \to \infty} (a_i'')^{(2)}(T_{17}, t) = (p_i)^{(2)}$ 104

$\lim_{G \to \infty} (b_i'')^{(2)}((G_{19}), t) = (r_i)^{(2)}$ 105

Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: 106

Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i = 16,17,18$

They satisfy Lipschitz condition:

$|(a_i'')^{(2)}(T_{17}', t) - (a_i'')^{(2)}(T_{17}, t)| \le (\hat{k}_{16})^{(2)}|T_{17} - T_{17}'|e^{-(\hat{M}_{16})^{(2)}t}$ 107

$|(b_i'')^{(2)}((G_{19})', t) - (b_i'')^{(2)}((G_{19}), t)| < (\hat{k}_{16})^{(2)}||(G_{19}) - (G_{19})'||e^{-(\hat{M}_{16})^{(2)}t}$ 108

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}', t)$ and $(a_i'')^{(2)}(T_{17}, t)$. (T_{17}', t) and (T_{17}, t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:

$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants 109

$$\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$$

Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$:

There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants

$(a_i)^{(2)}, (a_i^{'})^{(2)}, (b_i)^{(2)}, (b_i^{'})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i^{'})^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i^{'})^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i^{'})^{(3)}, (a_i^{''})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (b_i^{''})^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i^{''})^{(3)}, (b_i^{''})^{(3)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i^{''})^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i^{''})^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i^{'})^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i^{''})^{(3)}\,(T_{21}, t) = (p_i)^{(3)}$ $\lim_{G\to\infty}(b_i^{''})^{(3)}\,(G_{23}, t) = \ (r_i)^{(3)}$ **<u>Definition of</u>** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20,21,22}$	113
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(3)}(T_{21}^{'}, t) - (a_i^{''})^{(3)}(T_{21}, t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21} - \ T_{21}^{'}\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i^{''})^{(3)}(G_{23}{'}, t) - (b_i^{''})^{(3)}(G_{23}, t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}{'}\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}^{'}, t)$ and$(a_i^{''})^{(3)}(T_{21}, t)$. $(T_{21}^{'}, t)$ And (T_{21}, t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}} \ , \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25}, t) \le (p_i)^{(4)} \le (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}), t) \le (r_i)^{(4)} \le (b_i^{'})^{(4)} \le (\hat{B}_{24})^{(4)}$	117
$lim_{T_2 \to \infty} (a_i^{''})^{(4)} (T_{25}, t) = (p_i)^{(4)}$ $\lim_{G \to \infty} (b_i^{''})^{(4)} ((G_{27}), t) = (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition: $\|(a_i^{''})^{(4)}(T_{25}^{'}, t) - (a_i^{''})^{(4)}(T_{25}, t)\| \le (\hat{k}_{24})^{(4)}\|T_{25} - T_{25}^{'}\|e^{-(\hat{M}_{24})^{(4)}t}$ $\|(b_i^{''})^{(4)}((G_{27})^{'}, t) - (b_i^{''})^{(4)}((G_{27}), t)\| < (\hat{k}_{24})^{(4)}\|\|(G_{27}) - (G_{27})^{'}\|\|e^{-(\hat{M}_{24})^{(4)}t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'}, t)$ and$(a_i^{''})^{(4)}(T_{25}, t)$. $(T_{25}^{'}, t)$ and (T_{25}, t) are points belonging to the interval $[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}, \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i')^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i')^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i')^{(5)}, (a_i'')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (b_i'')^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i'')^{(5)}, (b_i'')^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29}, t) \le (p_i)^{(5)} \le (\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}), t) \le (r_i)^{(5)} \le (b_i')^{(5)} \le (\hat{B}_{28})^{(5)}$	122
$lim_{T_2 \to \infty}(a_i'')^{(5)}(T_{29}, t) = (p_i)^{(5)}$ $\lim_{G \to \infty}(b_i'')^{(5)}(G_{31}, t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\|(a_i'')^{(5)}(T_{29}', t) - (a_i'')^{(5)}(T_{29}, t)\| \le (\hat{k}_{28})^{(5)}\|T_{29} - T_{29}'\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i'')^{(5)}((G_{31})', t) - (b_i'')^{(5)}((G_{31}), t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31}) - (G_{31})'\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}', t)$ and $(a_i'')^{(5)}(T_{29}, t)$. (T_{29}', t) and (T_{29}, t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i'')^{(5)}(T_{29}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)}$ *and* $(\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)} (\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
$lim_{T_2 \to \infty} (a_i'')^{(6)} (T_{33}, t) = (p_i)^{(6)}$ $\lim_{G \to \infty} (b_i'')^{(6)} ((G_{35}), t) = (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$: Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	128
They satisfy Lipschitz condition: $\|(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\| \leq (\hat{k}_{32})^{(6)}\|T_{33} - T_{33}'\|e^{-(\hat{M}_{32})^{(6)}t}$ $\|(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}((G_{35}), t)\| < (\hat{k}_{32})^{(6)}\|\|(G_{35}) - (G_{35})'\|\|e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants	129

$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and\ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(YYYYYYY) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (ZZZZZZZ) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(AAAAAAAA) $\lim_{T_2 \to \infty} (a_i'')^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(BBBBBBBB)* $\lim_{G \to \infty} (b_i'')^{(7)} ((G_{39}), t) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	132
They satisfy Lipschitz condition: $\lvert (a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t) \rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}' \rvert e^{-(\hat{M}_{36})^{(7)} t}$ $\lvert (b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t) \rvert < (\hat{k}_{36})^{(7)} \lvert\lvert (G_{39}) - (G_{39})' \rvert\rvert e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the	

system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (CCCCCCCC) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (DDDDDDDD) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i^{'})^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i^{'})^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i^{'})^{(8)}, (a_i^{''})^{(8)}, (b_i)^{(8)}, (b_i^{'})^{(8)}, (b_i^{''})^{(8)} > 0, \quad i, j = 40,41,42$	136
The functions $(a_i^{''})^{(8)}, (b_i^{''})^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i^{''})^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138
$(b_i^{''})^{(8)}((G_{43}), t) \leq (r_i)^{(8)} \leq (b_i^{'})^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2 \to \infty} (a_i^{''})^{(8)} (T_{41}, t) = (p_i)^{(8)}$	140
$\lim_{G \to \infty} (b_i^{''})^{(8)} \left((G_{43}), t\right) = (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'}, t) - (a_i^{''})^{(8)}(T_{41}, t)\rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}^{'}\rvert e^{-(\hat{M}_{40})^{(8)} t}$	142

$\|(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}((G_{43}),t)\| < (\hat{k}_{40})^{(8)}\|\|(G_{43}) - (G_{43})'\|\|e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}$, $\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)},(\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)},(\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)},(a_i')^{(8)},(b_i)^{(8)},(b_i')^{(8)},(p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[(a_i)^{(8)} + (a_i')^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i')^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)},(a_i')^{(9)},(a_i'')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(b_i'')^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i'')^{(9)},(b_i'')^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i'')^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$ $(b_i'')^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i')^{(9)} \leq (\hat{B}_{44})^{(9)}$	146 A
$\lim_{T_2\to\infty}(a_i'')^{(9)}(T_{45},t) = (p_i)^{(9)}$ $\lim_{G\to\infty}(b_i'')^{(9)}(G_{47},t) = (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)}$: Where $(\hat{A}_{44})^{(9)},(\hat{B}_{44})^{(9)},(p_i)^{(9)}, (r_i)^{(9)}$ are positive constants and $i = 44,45,46$	
They satisfy Lipschitz condition:	

$$|(a_i'')^{(9)}(T_{45}',t) - (a_i'')^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i'')^{(9)}((G_{47})',t) - (b_i'')^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0), T_i(0)$:

$$G_i(t) \leq (\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t} , \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t} , \quad T_i(0) = T_i^0 > 0$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0), T_i(0)$

$$G_i(t) \leq (\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t} , \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t} , \quad T_i(0) = T_i^0 > 0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t) \leq (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t} , \quad G_i(0) = G_i^0 > 0$$

$T_i(t) \leq \ (\hat{Q}_{20} \ )^{(3)} e^{(\hat{M}_{20} \ )^{(3)} t}$, $T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) , T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24} \right)^{(4)} e^{(\hat{M}_{24} \ )^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24} \ )^{(4)} e^{(\hat{M}_{24} \ )^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) , T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28} \right)^{(5)} e^{(\hat{M}_{28} \ )^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{28} \ )^{(5)} e^{(\hat{M}_{28} \ )^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) , T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32} \right)^{(6)} e^{(\hat{M}_{32} \ )^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{32} \ )^{(6)} e^{(\hat{M}_{32} \ )^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) , T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36} \ )^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{36} \ )^{(7)} e^{(\hat{M}_{36} \ )^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) , T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40} \ )^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{40} \ )^{(8)} e^{(\hat{M}_{40} \ )^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0) , T_i(0)$:	153 B

$G_i(t) \leq \left(\hat{P}_{44}\right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}')^{(1)} - (b_{13}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}')^{(1)} - (b_{14}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}')^{(1)} - (b_{15}'')^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{16})^{(2)}$, $T_i^0 \leq (\hat{Q}_{16})^{(2)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}')^{(2)} + a_{16}'')^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}')^{(2)} + (a_{17}'')^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$

$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$

$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$

$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$

Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)},$

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$

By 161

$\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$

$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$

$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$

$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$

$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$

Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$

Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0, \; T_i(0) = T_i^0, \; G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)},$

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\,\hat{P}_{32}\,)^{(6)} \,, T_i^0 \leq (\,\hat{Q}_{32}\,)^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{32}\,)^{(6)} e^{(\,\hat{M}_{32}\,)^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{32}\,)^{(6)} e^{(\,\hat{M}_{32}\,)^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i \,,\, T_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\,\hat{P}_{36}\,)^{(7)} \,, T_i^0 \leq (\,\hat{Q}_{36}\,)^{(7)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{36}\,)^{(7)} e^{(\,\hat{M}_{36}\,)^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{36}\,)^{(7)} e^{(\,\hat{M}_{36}\,)^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{46}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{45}(s_{(44)}) \right] ds_{(44)}$	
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$G_{32}^{(2)}\lvert(a_{32}'')^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)-(a_{32}'')^{(6)}\left(T_{33}^{(2)},s_{(32)}\right)\rvert\ e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$ Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	
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Indeed let t_6 be so that for $t > t_6$ $(b_{33})^{(6)} - (b_i'')^{(6)}\left((G_{35})(t), t\right) < \varepsilon_6, T_{32}\,(t) > (m)^{(6)}$	
Then $\frac{dT_{33}}{dt} \geq (a_{33})^{(6)}(m)^{(6)} - \varepsilon_6 T_{33}$ which leads to $T_{33} \geq \left(\frac{(a_{33})^{(6)}(m)^{(6)}}{\varepsilon_6}\right)(1 - e^{-\varepsilon_6 t}) + T_{33}^0 e^{-\varepsilon_6 t}$ If we take t such that $e^{-\varepsilon_6 t} = \frac{1}{2}$ it results $T_{33} \geq \left(\frac{(a_{33})^{(6)}(m)^{(6)}}{2}\right), \quad t = log\frac{2}{\varepsilon_6}$ By taking now ε_6 sufficiently small one sees that T_{33} is unbounded. The same property holds for T_{34} if $\lim_{t\to\infty}(b_{34}'')^{(6)}\left((G_{35})(t), t(t), t\right) = (b_{34}')^{(6)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	254
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$\frac{(b_i)^{(7)}}{(\mathcal{M}_{36})^{(7)}}\left[\left((\widehat{Q}_{36})^{(7)} + T_j^0\right)e^{-\left(\frac{(\widehat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{36})^{(7)}\right] \leq (\widehat{Q}_{36})^{(7)}$	257
In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(\left((G_{39})^{(1)}, (T_{39})^{(1)}\right), \left((G_{39})^{(2)}, (T_{39})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t) - G_i^{(2)}(t)\right\|e^{-(\widehat{M}_{36})^{(7)}t}, \max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t) - T_i^{(2)}(t)\right\|e^{-(\widehat{M}_{36})^{(7)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{39})}, \widetilde{(T_{39})} : \left(\widetilde{(G_{39})}, \widetilde{(T_{39})}\right) = \mathcal{A}^{(7)}((G_{39}), (T_{39}))$ It results $\left\|\tilde{G}_{36}^{(1)} - \tilde{G}_i^{(2)}\right\| \leq \int_0^t (a_{36})^{(7)}\left\|G_{37}^{(1)} - G_{37}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\,ds_{(36)} +$ $\int_0^t\{(a_{36}')^{(7)}\left\|G_{36}^{(1)} - G_{36}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{-(\widehat{M}_{36})^{(7)}s_{(36)}} +$ $(a_{36}'')^{(7)}\left(T_{37}^{(1)}, s_{(36)}\right)\left\|G_{36}^{(1)} - G_{36}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}} +$	258

$G_{36}^{(2)}\lvert(a_{36}'')^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)-(a_{36}'')^{(7)}\left(T_{37}^{(2)},s_{(36)}\right)\rvert\ e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	
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Remark 32: There does not exist any t where $G_i\,(t)=0$ *and* $T_i\,(t)=0$ it results $G_i\,(t)\geq G_i^0 e^{\left[-\int_0^t\{(a_i')^{(7)}-(a_i'')^{(7)}(T_{37}(s_{(36)}),s_{(36)})\}ds_{(36)}\right]}\geq 0$ $T_i\,(t)\geq T_i^0 e^{(-(b_i')^{(7)}t)}>0$ for $\mathrm{t}>0$	261
Definition of $\left((\widehat{M}_{36})^{(7)}\right)_1,\left((\widehat{M}_{36})^{(7)}\right)_2$ *and* $\left((\widehat{M}_{36})^{(7)}\right)_3$: **Remark 33:** if G_{36} is bounded, the same property have also G_{37} *and* G_{38} . indeed if $G_{36}<(\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt}\leq\left((\widehat{M}_{36})^{(7)}\right)_1-(a_{37}')^{(7)}G_{37}$ and by integrating $G_{37}\leq\left((\widehat{M}_{36})^{(7)}\right)_2=G_{37}^0+2(a_{37})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_1/(a_{37}')^{(7)}$ In the same way , one can obtain $G_{38}\leq\left((\widehat{M}_{36})^{(7)}\right)_3=G_{38}^0+2(a_{38})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_2/(a_{38}')^{(7)}$ If G_{37} *or* G_{38} is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.	262
Remark 34: If G_{36} *is* bounded, from below, the same property holds for G_{37} *and* G_{38} . The proof is analogous with the preceding one. An analogous property is true if G_{37} is bounded from below.	263

Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(7)}((G_{39})(t),t)) = (b_{37}^{'})^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i^{''})^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$	264
Then $\frac{dT_{37}}{dt} \geq (a_{37})^{(7)}(m)^{(7)} - \varepsilon_7 T_{37}$ which leads to $T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{\varepsilon_7}\right)(1-e^{-\varepsilon_7 t}) + T_{37}^0 e^{-\varepsilon_7 t}$ If we take t such that $e^{-\varepsilon_7 t} = \frac{1}{2}$ it results $T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{2}\right), \quad t = log\frac{2}{\varepsilon_7}$ By taking now ε_7 sufficiently small one sees that T_{37} is unbounded. The same property holds for T_{38} if $\lim_{t\to\infty}(b_{38}^{''})^{(7)}\left((G_{39})(t),t\right) = (b_{38}^{'})^{(7)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	265
It is now sufficient to take $\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$ and to choose $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ large to have	266
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{Q}_{40})^{(8)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{40})^{(8)}\right] \leq (\hat{Q}_{40})^{(8)}$	268
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(((G_{43})^{(1)},(T_{43})^{(1)}),((G_{43})^{(2)},(T_{43})^{(2)})\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\|G_i^{(1)}(t) - G_i^{(2)}(t)\|e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+}\|T_i^{(1)}(t) - T_i^{(2)}(t)\|e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **Definition of** $\widetilde{(G_{43})}, \widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results	271

$\left\|\tilde{G}_{40}^{(1)}-\tilde{G}_i^{(2)}\right\| \leq \int_0^t (a_{40})^{(8)} \left\|G_{41}^{(1)}-G_{41}^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} ds_{(40)} +$ $\int_0^t \{(a'_{40})^{(8)} \left\|G_{40}^{(1)}-G_{40}^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} +$ $(a''_{40})^{(8)}(T_{41}^{(1)}, s_{(40)}) \left\|G_{40}^{(1)}-G_{40}^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} +$ $G_{40}^{(2)} \left\|(a''_{40})^{(8)}(T_{41}^{(1)}, s_{(40)}) - (a''_{40})^{(8)}(T_{41}^{(2)}, s_{(40)})\right\| \; e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} \} ds_{(40)}$	
Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
$\left\|(G_{43})^{(1)}-(G_{43})^{(2)}\right\| e^{-(\widehat{M}_{40})^{(8)} t} \leq$ $\frac{1}{(\widehat{M}_{40})^{(8)}}\left((a_{40})^{(8)} + (a'_{40})^{(8)} + (\widehat{A}_{40})^{(8)} + (\widehat{P}_{40})^{(8)}(\widehat{k}_{40})^{(8)}\right) d\left(\left((G_{43})^{(1)},(T_{43})^{(1)};\ (G_{43})^{(2)},(T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
<u>Remark 36:</u> The fact that we supposed $(a''_{40})^{(8)}$ and $(b''_{40})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)} e^{(\widehat{M}_{40})^{(8)} t}$ *and* $(\widehat{Q}_{40})^{(8)} e^{(\widehat{M}_{40})^{(8)} t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(8)}$ and $(b''_i)^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
<u>Remark 37</u> There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(8)} - (a''_i)^{(8)}(T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b'_i)^{(8)} t)} > 0$ for $\mathrm{t} > 0$	275
<u>Definition of</u> $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **<u>Remark 38:</u>** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a'_{41})^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a'_{41})^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a'_{42})^{(8)}$	276

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\big((G_{43})(t),t(t),t\big) = (b_{42}')^{(8)}$	279
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) = \sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})}, \widetilde{(T_{47})} : \big(\widetilde{(G_{47})}, \widetilde{(T_{47})}\big) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \le \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$
$\int_0^t \{(a_{44}^{'})^{(9)} |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$(a_{44}^{''})^{(9)} (T_{45}^{(1)}, s_{(44)}) |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$
$G_{44}^{(2)} |(a_{44}^{''})^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a_{44}^{''})^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right| e^{-(\widehat{M}_{44})^{(9)} t} \le \frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}^{'})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)}\right) d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}^{''})^{(9)}$ and $(b_{44}^{''})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(9)}$ and $(b_i^{''})^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \ge G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \ge 0$$

$$T_i(t) \ge T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \le \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$$G_{45} \le \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$$

In the same way , one can obtain

$$G_{46} \le \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t),t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t),t) = (b_{46}^{'})^{(9)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying

$$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14},t) + (a_{14}^{''})^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$$

$$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$$

Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: 281

By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: 282

By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$

Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- 283

If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by

$$(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \; if \; (\nu_0)^{(1)} < (\nu_1)^{(1)}$$

$$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \; (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$$

and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq$ $\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}] + G_{15}^0 e^{-(a_{15}')^{(1)}t})$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
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Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}), t\right) - (b_{17}^{''})^{(2)}\left((G_{19}), t\right) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
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Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},$ ***if*** $(\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)},$ ***if*** $(\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)},$ and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},$ ***if*** $(\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},$ ***if*** $(u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)},$ ***if*** $(u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)},$ and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},$ ***if*** $(\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{16}(t) \le G_{16}^0 e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{17}(t) \le \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \le G_{18}(t) \le$ $\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}] + G_{18}^0 e^{-(a_{18}')^{(2)}t})$	312
$T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \le T_{18}(t) \le$ $\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)}$ $(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \le -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \le -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \le -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G_{23}, t) - (b_{21}'')^{(3)}((G_{23}), t) \le -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
<u>**Definition of**</u> $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)}, \textbf{\textit{if}}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}, \textbf{\textit{if}}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)}, \textbf{\textit{if}}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}, \textbf{\textit{if}}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \textbf{\textit{if}}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}, \textbf{\textit{if}}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})}\left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)} - (b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)})}\left[e^{((R_1)^{(3)} + (r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \le -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \le -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \le -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big) - (b''_{25})^{(4)}\big((G_{27}), t\big) \le -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ ***if*** $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, ***if*** $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ ***if*** $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ ***if*** $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, ***if*** $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>**Definition of**</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>**Definition of**</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}, \; \boldsymbol{if} \; (\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}, \boldsymbol{if} \; (\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
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Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)} \left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t} \right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b'_{30})^{(5)}t}\right]+T_{30}^0e^{-(b'_{30})^{(5)}t}\leq T_{30}(t)\leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0e^{-(R_2)^{(5)}t}$	347
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Definition of $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}(u^{(6)})^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},$ ***if*** $(\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},$ ***if*** $(\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)},$ and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},$ ***if*** $(\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
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$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t}-e^{-(S_2)^{(7)}t}\right]+G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t}-e^{-(a_{38}')^{(7)}t}]+G_{38}^0 e^{-(a_{38}')^{(7)}t})$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t}-e^{-(b_{38}')^{(7)}t}\right]+T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^0 e^{-(R_2)^{(7)}t}$	369
<u>Definition of</u> $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}')^{(7)}$ $(R_2)^{(7)} = (b_{38}')^{(7)} - (r_{38})^{(7)}$	370
<u>Behavior of the solutions of equation</u> <u>Theorem 2:</u> If we denote and define <u>Definition of</u> $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}')^{(8)} + (a_{41}')^{(8)} - (a_{40}'')^{(8)}(T_{41}, t) + (a_{41}'')^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}')^{(8)} + (b_{41}')^{(8)} - (b_{40}'')^{(8)}\big((G_{43}), t\big) - (b_{41}'')^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$	371
<u>Definition of</u> $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}\ (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)}G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)}G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)} t}-e^{-(b'_{42})^{(8)} t}\right]+T_{42}^0 e^{-(b'_{42})^{(8)} t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t}-e^{-(R_2)^{(8)} t}\right]+T_{42}^0 e^{-(R_2)^{(8)} t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}((G_{47}), t) - (b''_{45})^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$	382
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Definition of $(\bar{\nu}_1)^{(9)}, , (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \textit{\textbf{if}}\ (\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, $\boldsymbol{if}$ $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, $\boldsymbol{if}$ $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, $\boldsymbol{if}$ $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

<u>Definition of</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$

$$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right) - (a''_{14})^{(1)}(T_{14}, t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \le \frac{d\nu^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \ge \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \le \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \le \nu^{(1)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \le (\bar{\nu}_1)^{(1)} \le \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \le \nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
<u>Definition of</u> $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **<u>Definition of</u>** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
<u>Particular case :</u> If $(a_{16}^{''})^{(2)} = (a_{17}^{''})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b_{16}^{''})^{(2)} = (b_{17}^{''})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain 398

$$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}^{'})^{(3)} - (a_{21}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right) - (a_{21}^{''})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$$

Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ 399

It follows

$$-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$$

400

From which one obtains

For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$

$$\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$$

Definition of $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(3)}(t)$:-

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:- For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$ $\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}$, $\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$ it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$	
In the same manner , we get $\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}$, $\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$ From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$	409
If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, $(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$ $\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$	410
If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain $(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(5)}(t)$:- $(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)}$, $\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(5)}(t)$:- $(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)}$, $\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :**	411

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>**Proof**</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ <u>**Definition of**</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains <u>**Definition of**</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain	415

$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)}G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

Proof : From global equations we obtain 416

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

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Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations	426
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b'_{16})^{(2)}(r_{17})^{(2)} - (b'_{17})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a''_i)^{(3)} and\ (b''_i)^{(3)}$ are independent on t , and the conditions with the notations $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a'_{21})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b'_{20})^{(3)}(r_{21})^{(3)} - (b'_{21})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a''_i)^{(4)} and\ (b''_i)^{(4)}$ are independent on t , and the conditions with the notations $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a'_{25})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b'_{24})^{(4)}(r_{25})^{(4)} - (b'_{25})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a''_i)^{(5)} and\ (b''_i)^{(5)}$ are independent on t , and the conditions with the notations $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a'_{29})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b'_{28})^{(5)}(r_{29})^{(5)} - (b'_{29})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a''_i)^{(6)} and\ (b''_i)^{(6)}$ are independent on t , and the conditions with the notations $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a'_{33})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b'_{32})^{(6)}(r_{33})^{(6)} - (b'_{33})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a''_i)^{(7)} and\ (b''_i)^{(7)}$ are independent on t , and the conditions with the notations $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a'_{37})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b'_{36})^{(7)}(r_{37})^{(7)} - (b'_{37})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a''_i)^{(8)} and\ (b''_i)^{(8)}$ are independent on t , and the conditions with the notations $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a'_{41})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a''_i)^{(9)} and\ (b''_i)^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a'_{45})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b'_{44})^{(9)}(r_{45})^{(9)} - (b'_{45})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}')^{(7)} - (b_{36}'')^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}')^{(7)} - (b_{37}'')^{(7)}(G_{39})\,]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}')^{(7)} - (b_{38}'')^{(7)}(G_{39})\,]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}')^{(8)} + (a_{41}'')^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}')^{(8)} - (b_{40}'')^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}')^{(8)} - (b_{41}'')^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}')^{(8)} - (b_{42}'')^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}')^{(9)} - (b_{44}'')^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}')^{(9)} - (b_{45}'')^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}')^{(9)} - (b_{46}'')^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}')^{(1)}(a_{14}')^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}')^{(1)}(a_{14}'')^{(1)}(T_{14}) + (a_{14}')^{(1)}(a_{13}'')^{(1)}(T_{14}) + (a_{13}'')^{(1)}(T_{14})(a_{14}'')^{(1)}(T_{14}) = 0$	485
Proof: (ee) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19})=(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)}-(a_{16})^{(2)}(a_{17})^{(2)}+(a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17})+(a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17})+(a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17})=0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23})=(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}+(a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21})+(a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21})+(a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21})=0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27})=(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}+(a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25})+(a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25})+(a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25})=0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31})=(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}+(a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29})+(a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29})+(a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29})=0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35})=(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}+(a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33})+(a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33})+(a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33})=0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39})=(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)}-(a_{36})^{(7)}(a_{37})^{(7)}+(a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37})+(a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37})+(a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37})=0$	491
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Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47})=(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)}-(a_{44})^{(9)}(a_{45})^{(9)}+(a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45})+(a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45})+$	492 A

$(a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T_{14}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^* for which $f(T_{14}^*) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}^{'})^{(1)}+(a_{13}^{''})^{(1)}(T_{14}^*)]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}(T_{14}^*)]}$	493
Definition and uniqueness of T_{17}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^* for which $f(T_{17}^*) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}^{'})^{(2)}+(a_{16}^{''})^{(2)}(T_{17}^*)]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}(T_{17}^*)]}$	495
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Definition and uniqueness of T_{25}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^* for which $f(T_{25}^*) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^*)]}$	497
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equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T^*_{33})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T^*_{33})]}$	
Definition and uniqueness of T^*_{37} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T^*_{37} for which $f(T^*_{37}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T^*_{37})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T^*_{37})]}$	500
Definition and uniqueness of T^*_{41} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T^*_{41} for which $f(T^*_{41}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T^*_{41})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T^*_{41})]}$	501
Definition and uniqueness of T^*_{45} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T^*_{45} for which $f(T^*_{45}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T^*_{45})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T^*_{45})]}$	501 A
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By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b'_{16})^{(2)}(b''_{17})^{(2)}(G_{19}) + (b'_{17})^{(2)}(b''_{16})^{(2)}(G_{19})\right] + (b''_{16})^{(2)}(G_{19})(b''_{17})^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27}) + (b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right] + (b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31}) + (b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right] + (b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35}) + (b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right] + (b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39}) + (b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right] + (b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
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Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^* = \frac{(a_{24})^{(4)}G_{25}^*}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)}G_{25}^*}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)}T_{25}^*}{[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)}T_{25}^*}{[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*)=0$, T_{29}^* given by $f(T_{29}^*)=0$ and $G_{28}^* = \frac{(a_{28})^{(5)}G_{29}^*}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)}G_{29}^*}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)}T_{29}^*}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)}T_{29}^*}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*)=0$, T_{33}^* given by $f(T_{33}^*)=0$ and $G_{32}^* = \frac{(a_{32})^{(6)}G_{33}^*}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)}G_{33}^*}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)}T_{33}^*}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)}T_{33}^*}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*)=0$, T_{37}^* given by $f(T_{37}^*)=0$ and $G_{36}^* = \frac{(a_{36})^{(7)}G_{37}^*}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)}G_{37}^*}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)}T_{37}^*}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)}T_{37}^*}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*)=0$, T_{41}^* given by $f(T_{41}^*)=0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)}-(b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)}-(b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)}-(b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)}-(b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ 532

$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$ 533

taking into account equations and neglecting the terms of power 2, we obtain

$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$ 534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$ 535

$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$ 536

$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$ 537

$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$ 538

$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$ 539

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Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$$

Then taking into account equations and neglecting the terms of power 2, we obtain

$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$ 541

$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$ 542

$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$ 543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)}$, $\frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)}$, $\frac{\partial (b_i^{''})^{(5)}}{\partial G_j}((G_{31})^{*}) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial(b_i'')^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{37})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b''_i)^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a'_{36})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a'_{37})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b''_i)^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 9:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **<u>Proof:</u> Denote**	586 A
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$	

$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$

$+((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)})\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$

$+$

$((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)})\{((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)})$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$

$+((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)})\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\}=0$

$+$

$((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)})\{((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)})$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$$+\left(\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$$

$$+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$$

$$\left(\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(4)}+(b_{26}')^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a_{26}')^{(4)}+(p_{26})^{(4)}\right)$$

$$\left[\left(\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$$

$$+\left(\left((\lambda)^{(4)}+(a_{25}')^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}')^{(4)}+(b_{25}')^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}')^{(4)}+(a_{25}')^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$$

$$+\left((\lambda)^{(4)}+(a_{24}')^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$$

$$\left(\left((\lambda)^{(4)}+(b_{24}')^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$$

+

$$\left((\lambda)^{(5)}+(b_{30}')^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a_{30}')^{(5)}+(p_{30})^{(5)}\right)$$

$$\left[\left(\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$$

$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$

$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$

$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$

$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$

$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$

$+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$

$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$

$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$

$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$

$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$

$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$

$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$

$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$

$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$

$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$

$+\left(\left((\lambda)^{(7)}+(a_{37}^{'})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}^{'})^{(7)}+(b_{37}^{'})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}^{'})^{(7)}+(a_{37}^{'})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$

$+\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(8)}+(b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}^{'})^{(8)}+(p_{42})^{(8)}\right)$

$\left[\left(\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(\left((\lambda)^{(8)}+(a_{41}^{'})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+\left((\lambda)^{(8)}+(a_{40}^{'})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(9)}+(b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)$

$\left[\left(\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)}+(a_{45}')^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^2+\left((b_{44}')^{(9)}+(b_{45}')^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^2+\left((a_{44}')^{(9)}+(a_{45}')^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}')^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION THIRTY TWO

Monte Carlo Studies Of Supersymmetric Matrix Quantum Mechanics

INTRODUCTION—VARIABLES USED

Monte Carlo Studies of Supersymmetric Matrix Quantum Mechanics with Sixteen Supercharges at Finite Temperature Konstantinos N. Anagnostopoulos, Masanori Hanada, Jun Nishimura, and Shingo Takeuchi Phys. Rev. Lett. 100, 021601 – Published 15 January 2008

(1) Authors present the first Monte Carlo results for (e) supersymmetric matrix quantum mechanics with (e&eb) 16 supercharges at finite temperature.

(2) The recently proposed nonlattice simulation enables (eb) to include (e) the effects of (e&eb) fermionic matrices in a transparent and reliable manner.

(3) The internal energy nicely interpolates (e&eb) the weak coupling behavior obtained by (e) the high temperature expansion, and (e&eb) the strong coupling behavior predicted from (e) the dual black-hole geometry.

(4) The Polyakov line asymptotes at low temperature to a (e&eb) characteristic behavior for a deconfined theory, suggesting (eb) the absence of a phase transition.

(5) These results provide (eb) highly nontrivial evidence for the gauge-gravity duality. Received 4

September 2007DOI:http://dx.doi.org/10.1103/PhysRevLett.100.021601	
NOTATION	
Module One Authors present the first Monte Carlo results for (e) supersymmetric matrix quantum mechanics with (e&eb) 16 supercharges at finite temperature	
G_{13} : Category one of **Monte Carlo results;** supersymmetric matrix quantum mechanics with (e&eb) 16 supercharges at finite temperature G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of supersymmetric matrix quantum mechanics with (e&eb) 16 supercharges at finite temperature **;Monte Carlo results** T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two Authors present the **first Monte Carlo results for supersymmetric matrix quantum mechanics** with (e&eb) 16 supercharges at finite temperature	
G_{16} : Category one of **first Monte Carlo results for supersymmetric matrix quantum mechanics;** 16 supercharges at finite temperature G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of16 supercharges at finite temperature; **first Monte Carlo results for supersymmetric matrix quantum mechanics** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three The recently proposed nonlattice simulation enables (eb) to include (e) the effects of (e&eb) fermionic matrices in a transparent and reliable manner	
G_{20} : Category one of **nonlattice simulation;** effects of (e&eb) fermionic matrices in a transparent and reliable manner G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of effects of (e&eb) fermionic matrices in a transparent and reliable manner; **nonlattice simulation** T_{21} : Category two of SAS	

T_{22} : Category three of SAS	
Module four The internal energy nicely interpolates (e&eb) the weak coupling behavior obtained by (e) the high temperature expansion, and (e&eb) the strong coupling behavior predicted from (e) the dual black-hole geometry	
G_{24} : Category one of **internal energy;** weak coupling behavior obtained by (e) the high temperature expansion, and (e&eb) the strong coupling behavior predicted from (e) the dual black-hole geometry G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of weak coupling behavior obtained by (e) the high temperature expansion, and (e&eb) the strong coupling behavior predicted from (e) the dual black-hole geometry **;internal energy** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five The internal energy nicely interpolates the weak coupling behavior obtained by (e) the high temperature expansion, and (e&eb) the strong coupling behavior predicted from (e) the dual black-hole geometry	
G_{28} : Category one of high temperature expansion, and (e&eb) the strong coupling behavior predicted from (e) the dual black-hole geometry G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of internal energy nicely interpolates the weak coupling behavior T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six The internal energy nicely interpolates the weak coupling behavior obtained by the high temperature expansion, and (e&eb) the strong coupling behavior predicted from the dual black-hole geometry	
G_{32} : Category one of **internal energy nicely interpolates the weak coupling behavior obtained by the high temperature expansion;** strong coupling behavior predicted from the dual black-hole geometry G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of strong coupling behavior predicted from the dual black-hole geometry; **internal**	

energy nicely interpolates the weak coupling behavior obtained by the high temperature expansion T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven The Polyakov line asymptotes at low temperature to a (e&eb) characteristic behavior for a deconfined theory, suggesting (eb) the absence of a phase transition	
G_{36} : Category one of **Polyakov line asymptotes at low temperature;** characteristic behavior for a deconfined theory, suggesting (eb) the absence of a phase transition G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of characteristic behavior for a deconfined theory, suggesting (eb) the absence of a phase transition **;Polyakov line asymptotes at low temperature** T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight The Polyakov line asymptotes at low temperature to a characteristic behavior for a deconfined theory, suggesting (eb) the absence of a phase transition	
G_{40} : Category one of Polyakov line asymptotes at low temperature to a characteristic behavior for a deconfined theory G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of absence of a phase transition T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine These results provide (eb) highly nontrivial evidence for the gauge-gravity duality. Received 4 September 2007DOI:http://dx.doi.org/10.1103/PhysRevLett.100.021601	
G_{44} : Category one of results G_{45} : Category two of SAS	

G_{46} : Category three of SAS	
T_{44} : Category one of highly nontrivial evidence for the gauge-gravity duality T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8

$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b_{16}^{''})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30

$+(a''_{28})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)}((G_{31}),t) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}((G_{35}),t)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}((G_{35}),t)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}((G_{35}),t)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}((G_{39}),t)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}((G_{39}),t)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}((G_{39}),t)\right]T_{38}$	*42*
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}((G_{43}),t)\right]T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}((G_{43}),t)\right]T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}((G_{43}),t)\right]T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51

$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}((G_{47}),t)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}((G_{47}),t)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}((G_{47}),t)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}((G_{47}),t) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*55*
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	*56*
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	*57*
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58

$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	60
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{bmatrix} G_{18}$	63
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3	

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\ \boxed{-(b''_{13})^{(1,1,)}(G,t)}\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\ \boxed{-(b''_{14})^{(1,1,)}(G,t)}\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\ \boxed{-(b''_{15})^{(1,1,)}(G,t)}\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix}\right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3	

$-(b''_{36})^{(7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3 $-(b''_{40})^{(8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3 $-(b''_{44})^{(9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\left[\begin{matrix}(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21},t)+(a''_{16})^{(2,2,2)}(T_{17},t)+(a''_{13})^{(1,1,1,)}(T_{14},t)\\+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)\\+(a''_{36})^{(7,7,7,7)}(T_{37},t)+(a''_{40})^{(8,8,8,8)}(T_{41},t)+(a''_{44})^{(9,9,9)}(T_{45},t)\end{matrix}\right]G_{20}$	67
$\frac{dG_{21}}{dt}=(a_{21})^{(3)}G_{20}-\left[\begin{matrix}(a'_{21})^{(3)}+(a''_{21})^{(3)}(T_{21},t)+(a''_{17})^{(2,2,2)}(T_{17},t)+(a''_{14})^{(1,1,1,)}(T_{14},t)\\+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)\\+(a''_{37})^{(7,7,7,7)}(T_{37},t)+(a''_{41})^{(8,8,8,8)}(T_{41},t)+(a''_{45})^{(9,9,9)}(T_{45},t)\end{matrix}\right]G_{21}$	68
$\frac{dG_{22}}{dt}=(a_{22})^{(3)}G_{21}-\left[\begin{matrix}(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21},t)+(a''_{18})^{(2,2,2)}(T_{17},t)+(a''_{15})^{(1,1,1,)}(T_{14},t)\\+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)\\+(a''_{38})^{(7,7,7,7)}(T_{37},t)+(a''_{42})^{(8,8,8,8)}(T_{41},t)+(a''_{46})^{(9,9,9)}(T_{45},t)\end{matrix}\right]G_{22}$	69
$+(a''_{20})^{(3)}(T_{21},t)$, $+(a''_{21})^{(3)}(T_{21},t)$, $+(a''_{22})^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a''_{36})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3 $+(a''_{40})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3 $+(a''_{44})^{(9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt}=(b_{20})^{(3)}T_{21}-\left[\begin{matrix}(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23},t)-(b''_{16})^{(2,2,2)}(G_{19},t)-(b''_{13})^{(1,1,1,)}(G,t)\\-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)\\-(b''_{36})^{(7,7,7,7)}(G_{39},t)-(b''_{40})^{(8,8,8,8)}(G_{43},t)-(b''_{44})^{(9,9,9)}(G_{47},t)\end{matrix}\right]T_{20}$	70

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21}$$	71
$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22}$$	72

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24}$$	73
$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25}$$	74
$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$$	75

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients$ $category$ 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation*

$coefficient\ \ for\ category\ 1,2\ and\ 3$

$\boxed{+(a_{32}'')^{(6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,)}(T_{33},t)}$ $are\ third\ \ augmentation$

$coefficient\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a_{13}'')^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1)}(T_{14},t)}$

$are\ fourth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a_{16}'')^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2)}(T_{17},t)}$

$are\ fifth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a_{20}'')^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3)}(T_{21},t)}$

$are\ sixth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a_{36}'')^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7)}(T_{37},t)}$

$are\ seventh\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a_{40}'')^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8)}(T_{41},t)}$

$are\ eighth\ augmentation\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a_{46}'')^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b_{24}')^{(4)} \boxed{-(b_{24}'')^{(4)}(G_{27},t)} \ \boxed{-(b_{28}'')^{(5,5,)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1)}(G,t)} \ \boxed{-(b_{16}'')^{(2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b_{25}')^{(4)} \boxed{-(b_{25}'')^{(4)}(G_{27},t)} \ \boxed{-(b_{29}'')^{(5,5,)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1)}(G,t)} \ \boxed{-(b_{17}'')^{(2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{37}'')^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b_{26}')^{(4)} \boxed{-(b_{26}'')^{(4)}(G_{27},t)} \ \boxed{-(b_{30}'')^{(5,5,)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1)}(G,t)} \ \boxed{-(b_{18}'')^{(2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}'')^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

$Where$ $\boxed{-(b_{24}'')^{(4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4)}(G_{27},t)}$ $are\ first\ detrition\ coefficients$

$for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{28}'')^{(5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,)}(G_{31},t)}$ $are\ second\ detrition\ coefficients$

$for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{32}'')^{(6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,)}(G_{35},t)}$ $are\ third\ detrition\ coefficients$

$for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{13}'')^{(1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,1,1)}(G,t)}$

$are\ fourth\ \ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{16}'')^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2)}(G_{19},t)}$

$are\ fifth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{20}'')^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3)}(G_{23},t)}$

$are\ sixth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{36}'')^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b_{40}'')^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b_{46}'')^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a_{28}')^{(5)} \boxed{+(a_{28}'')^{(5)}(T_{29},t)} \boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28} \quad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a_{29}')^{(5)} \boxed{+(a_{29}'')^{(5)}(T_{29},t)} \boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29} \quad 80$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a_{30}')^{(5)} \boxed{+(a_{30}'')^{(5)}(T_{29},t)} \boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)} \boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30} \quad 81$$

Where $\boxed{+(a_{28}'')^{(5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a_{24}'')^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a_{32}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a_{16}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a_{20}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a_{36}'')^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a_{46}'')^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b_{28}')^{(5)} \boxed{-(b_{28}'')^{(5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,)}(G_{27},t)} \boxed{-(b_{32}'')^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28} \quad 82$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{array}{c} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{29} \quad 83$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{array}{c} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{array}\right] T_{30} \quad 84$$

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{array}{c} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{array}\right] G_{32} \quad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{array}{c} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{array}\right] G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{array}{c} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{array}\right] G_{34} \quad 87$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{28}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{24}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a_{16}'')^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a_{20}'')^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a_{44}'')^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{46}'')^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b_{32}')^{(6)} \boxed{-(b_{32}'')^{(6)}(G_{35},t)} \boxed{-(b_{28}'')^{(5,5,5)}(G_{31},t)} \boxed{-(b_{24}'')^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b_{33}')^{(6)} \boxed{-(b_{33}'')^{(6)}(G_{35},t)} \boxed{-(b_{29}'')^{(5,5,5)}(G_{31},t)} \boxed{-(b_{25}'')^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b_{17}'')^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{37}'')^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b_{34}')^{(6)} \boxed{-(b_{34}'')^{(6)}(G_{35},t)} \boxed{-(b_{30}'')^{(5,5,5)}(G_{31},t)} \boxed{-(b_{26}'')^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b_{18}'')^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}'')^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34} \quad 90$$

$\boxed{-(b_{32}'')^{(6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{28}'')^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{24}'')^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b_{13}'')^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{16}'')^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b_{20}'')^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b_{36}'')^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b_{40}'')^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b_{46}'')^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a_{36}')^{(7)} \boxed{+(a_{36}'')^{(7)}(T_{37},t)} \boxed{+(a_{16}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}'')^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	91
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a_{37}')^{(7)} \boxed{+(a_{37}'')^{(7)}(T_{37},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	92
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a_{38}')^{(7)} \boxed{+(a_{38}'')^{(7)}(T_{37},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	93
Where $\boxed{(a_{36}'')^{(7)}(T_{37},t)}$, $\boxed{(a_{37}'')^{(7)}(T_{37},t)}$, $\boxed{(a_{38}'')^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{16}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}'')^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{42}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{40}'')^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3	

$+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	94
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	
Where $-(b''_{36})^{(7)}(G_{39},t)$, $-(b''_{37})^{(7)}(G_{39},t)$, $-(b''_{38})^{(7)}(G_{39},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)$ are second detrition coefficients for category 1, 2 and 3 $-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)$, $-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$

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$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$\frac{dT_{40}}{dt} =$

$$(b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a_{45}^{'})^{(9)} \boxed{+(a_{45}^{''})^{(9)}(T_{45},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a_{46}^{'})^{(9)} \boxed{+(a_{46}^{''})^{(9)}(T_{37},t)} \boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a_{44}^{''})^{(9)}(T_{45},t)}$, $\boxed{+(a_{45}^{''})^{(9)}(T_{45},t)}$, $\boxed{+(a_{46}^{''})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{38}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b_{44}^{'})^{(9)} \boxed{-(b_{44}^{''})^{(9)}(G_{47},t)} \boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} =$$

$(b_{45})^{(9)}T_{44} - \left[\begin{array}{c} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{array} \right] T_{14}$	
$\frac{dT_{46}}{dt} =$ $(b_{46})^{(9)}T_{45} - \left[\begin{array}{c} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{array} \right] T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b'_i)^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t) = \ (r_i)^{(1)}$	98

Definition of $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14} - T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G - G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(\mathrm{p}_i)^{(2)}, (\mathrm{r}_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq \left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i')^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2 \to \infty} (a_i'')^{(2)} (T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G \to \infty} (b_i'')^{(2)} \left((G_{19}),t\right) = (r_i)^{(2)}$	105

Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}$ are positive constants and $i = 16,17,18$	106
They satisfy Lipschitz condition:	
$\lvert (a_i'')^{(2)}(T_{17}', t) - (a_i'')^{(2)}(T_{17}, t) \rvert \leq (\hat{k}_{16})^{(2)} \lvert T_{17} - T_{17}' \rvert e^{-(\hat{M}_{16})^{(2)} t}$	107
$\lvert (b_i'')^{(2)}((G_{19})', t) - (b_i'')^{(2)}\big((G_{19}), t\big) \rvert < (\hat{k}_{16})^{(2)} \lvert\lvert (G_{19}) - (G_{19})' \rvert\rvert e^{-(\hat{M}_{16})^{(2)} t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}', t)$ and $(a_i'')^{(2)}(T_{17}, t)$. (T_{17}', t) and (T_{17}, t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} \ , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and \ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)} + (a_i')^{(2)} + \ (\hat{A}_{16})^{(2)} + \ (\hat{P}_{16})^{(2)} \ (\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)} + (b_i')^{(2)} + \ (\hat{B}_{16})^{(2)} + \ (\hat{Q}_{16})^{(2)} \ \ (\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \leq (p_i)^{(3)} \leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \leq \ (r_i)^{(3)} \leq (b_i')^{(3)} \leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty} (a_i'')^{(3)} \, (T_{21}, t) = (p_i)^{(3)}$	113

$\lim_{G\to\infty}(b_i^{''})^{(3)}(G_{23},t) = (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20,21,22}$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(3)}(T_{21}',t) - (a_i^{''})^{(3)}(T_{21},t)\rvert \le (\hat{k}_{20})^{(3)}\lvert T_{21} - T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i^{''})^{(3)}(G_{23}',t) - (b_i^{''})^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23} - G_{23}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(3)}(T_{21}',t)$ and$(a_i^{''})^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i^{''})^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i^{''})^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i')^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25},t) \le (p_i)^{(4)} \le (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}),t) \le (r_i)^{(4)} \le (b_i')^{(4)} \le (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$	118

$\lim_{G\to\infty}(b_i^{''})^{(4)}\big((G_{27}),t\big)= \ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i=24,25,26}$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(4)}(T_{25}^{'},t)-(a_i^{''})^{(4)}(T_{25},t)\rvert\le(\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t)-(b_i^{''})^{(4)}\big((G_{27}),t\big)\rvert<(\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	119
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Definition of $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
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$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t) = (p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}$ are positive constants and $i = 28,29,30$	123
They satisfy Lipschitz condition: $\|(a_i'')^{(5)}(T_{29}',t) - (a_i'')^{(5)}(T_{29},t)\| \leq (\hat{k}_{28})^{(5)}\|T_{29} - T_{29}'\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i'')^{(5)}((G_{31})',t) - (b_i'')^{(5)}((G_{31}),t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31}) - (G_{31})'\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}',t)$ and $(a_i'')^{(6)}(T_{33},t)$. (T_{33}',t) and (T_{33},t) are points belonging to the interval $[(\hat{k}_{32})^{(6)},(\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)},(\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)},(\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
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Where we suppose	
(EEEEEEEE) $(a_i)^{(7)},(a_i')^{(7)},(a_i'')^{(7)},(b_i)^{(7)},(b_i')^{(7)},(b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (FFFFFFFF) The functions $(a_i'')^{(7)},(b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$:	131

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(GGGGGGGG) $\lim_{T_2\to\infty} (a_i'')^{(7)}(T_{37},t) = (p_i)^{(7)}$ *(HHHHHHHH)* $\lim_{G\to\infty} (b_i'')^{(7)}((G_{39}),t) = (r_i)^{(7)}$ **Definition of** $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$	132
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Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (IIIIIII) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
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Where we suppose	

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They satisfy Lipschitz condition:	
$\lvert(a_i^{''})^{(8)}(T_{41}^{'}, t) - (a_i^{''})^{(8)}(T_{41}, t)\rvert \leq (\hat{k}_{40})^{(8)} \lvert T_{41} - T_{41}^{'} \rvert e^{-(\hat{M}_{40})^{(8)} t}$	142
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Where we suppose	
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ ,\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i^{'})^{(9)},(b_i)^{(9)},(b_i^{'})^{(9)},(p_i)^{(9)},\ (r_i)^{(9)},i=44,45,46,$ satisfy the inequalities	

$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i')^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i')^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
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Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153
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By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)} \right) \right) G_{13}\left(s_{(13)}\right) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}\left(s_{(13)}\right) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)} \right) \right) G_{14}\left(s_{(13)}\right) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}\left(s_{(13)}\right) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)} \left(T_{14}\left(s_{(13)}\right), s_{(13)} \right) \right) G_{15}\left(s_{(13)}\right) \right] ds_{(13)}$	

$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}\left(G(s_{(13)}), s_{(13)}\right)\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}\left(G(s_{(13)}), s_{(13)}\right)\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}\left(G(s_{(13)}), s_{(13)}\right)\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{16})^{(2)}, T_i^0 \leq (\hat{Q}_{16})^{(2)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}\left(T_{17}(s_{(16)}), s_{(16)}\right)\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}\left(T_{17}(s_{(16)}), s_{(17)}\right)\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}\left(T_{17}(s_{(16)}), s_{(16)}\right)\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{20})^{(3)}, T_i^0 \leq (\hat{Q}_{20})^{(3)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	

By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\hat{P}_{28})^{(5)} \, , T_i^0 \leq (\hat{Q}_{28})^{(5)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i \, , \, T_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \, , \, T_i(0) = T_i^0 \, , \, G_i^0 \leq (\hat{P}_{32})^{(6)} \, , T_i^0 \leq (\hat{Q}_{32})^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	

$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}\left(s_{(32)}\right) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)} \left(G_{35}\left(s_{(32)}\right), s_{(32)} \right) \right) T_{34}\left(s_{(32)}\right) \right] d s_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{36})^{(7)} , T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a'_{36})^{(7)} + a''_{36})^{(7)} \left(T_{37}\left(s_{(36)}\right), s_{(36)} \right) \right) G_{36}\left(s_{(36)}\right) \right] d s_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}\left(s_{(36)}\right) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)} \left(T_{37}\left(s_{(36)}\right), s_{(36)} \right) \right) G_{37}\left(s_{(36)}\right) \right] d s_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)} \left(T_{37}\left(s_{(36)}\right), s_{(36)} \right) \right) G_{38}\left(s_{(36)}\right) \right] d s_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)} \left(G_{39}\left(s_{(36)}\right), s_{(36)} \right) \right) T_{36}\left(s_{(36)}\right) \right] d s_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}\left(s_{(36)}\right) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} \left(G_{39}\left(s_{(36)}\right), s_{(36)} \right) \right) T_{37}\left(s_{(36)}\right) \right] d s_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} \left(G_{39}\left(s_{(36)}\right), s_{(36)} \right) \right) T_{38}\left(s_{(36)}\right) \right] d s_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 , T_i(0) = T_i^0 , G_i^0 \leq (\hat{P}_{40})^{(8)} , T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	

By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	167

$G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0 \right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0} \right)} + (\hat{P}_{13})^{(1)} \right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}} \right) \right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)} t\right) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1 \right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0 \right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0} \right)} + (\hat{P}_{16})^{(2)} \right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
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From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
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From which it follows that	174

$(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0+\int_0^t\left[(a_{28})^{(5)}\left(G_{29}^0+(\hat{P}_{28})^{(5)}e^{(\hat{M}_{28})^{(5)}s_{(28)}}\right)\right]ds_{(28)}=$ $\left(1+(a_{28})^{(5)}t\right)G_{29}^0+\frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t}-1\right)$	
From which it follows that $(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{P}_{28})^{(5)}+G_{29}^0\right)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)}+(\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
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From which it follows that $(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)}+(\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for G_{25} , G_{26}, T_{24}, T_{25}, T_{26}	177
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From which it follows that $(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$	

(G_i^0) is as defined in the statement of theorem 7	
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From which it follows that $(G_{44}(t) - G_{44}^0) e^{-(\hat{M}_{44})^{(9)} t} \le \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}} \left[((\hat{P}_{44})^{(9)} + G_{45}^0) e^{\left(-\frac{(\hat{P}_{44})^{(9)} + G_{45}^0}{G_{45}^0}\right)} + (\hat{P}_{44})^{(9)} \right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for $G_{45}, G_{46}, T_{44}, T_{45}, T_{46}$	
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$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} \left[((\hat{Q}_{13})^{(1)} + T_j^0) e^{-\left(\frac{(\hat{Q}_{13})^{(1)} + T_j^0}{T_j^0}\right)} + (\hat{Q}_{13})^{(1)} \right] \le (\hat{Q}_{13})^{(1)}$	184
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$d\left((G^{(1)},T^{(1)}),(G^{(2)},T^{(2)})\right) =$

$\sup_i\{\max_{t\in\mathbb{R}_+} \left|G_i^{(1)}(t) - G_i^{(2)}(t)\right| e^{-(\hat{M}_{13})^{(1)}t}, \max_{t\in\mathbb{R}_+} \left|T_i^{(1)}(t) - T_i^{(2)}(t)\right| e^{-(\hat{M}_{13})^{(1)}t}\}$

Indeed if we denote

Definition of $\tilde{G},\tilde{T}$: $(\tilde{G},\tilde{T}) = \mathcal{A}^{(1)}(G,T)$

It results

$\left|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{13})^{(1)} \left|G_{14}^{(1)} - G_{14}^{(2)}\right| e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}}\, ds_{(13)} +$

$\int_0^t \{(a_{13}')^{(1)} \left|G_{13}^{(1)} - G_{13}^{(2)}\right| e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{-(\hat{M}_{13})^{(1)}s_{(13)}} +$

$(a_{13}'')^{(1)}\left(T_{14}^{(1)}, s_{(13)}\right)\left|G_{13}^{(1)} - G_{13}^{(2)}\right| e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}} +$

$G_{13}^{(2)} |(a_{13}'')^{(1)}\left(T_{14}^{(1)}, s_{(13)}\right) - (a_{13}'')^{(1)}\left(T_{14}^{(2)}, s_{(13)}\right)|\ e^{-(\hat{M}_{13})^{(1)}s_{(13)}} e^{(\hat{M}_{13})^{(1)}s_{(13)}}\} ds_{(13)}$

Where $s_{(13)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses it follows

$\left|G^{(1)} - G^{(2)}\right| e^{-(\hat{M}_{13})^{(1)}t} \leq$ 186

$\frac{1}{(\hat{M}_{13})^{(1)}}\left((a_{13})^{(1)} + (a_{13}')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}\right) d\left((G^{(1)},T^{(1)};\ G^{(2)},T^{(2)})\right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 1: The fact that we supposed $(a_{13}'')^{(1)}$ and $(b_{13}'')^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$ *and* $(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(1)}$ and $(b_i'')^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(\text{and not on } t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 19 to 24 it results

$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(1)} - (a_i'')^{(1)}(T_{14}(s_{(13)}), s_{(13)})\} ds_{(13)}\right]} \geq 0$

$T_i(t) \geq T_i^0 e^{\left(-(b_i')^{(1)}t\right)} > 0 \quad \text{for } t > 0$

Definition of $\left((\hat{M}_{13})^{(1)}\right)_1, \left((\hat{M}_{13})^{(1)}\right)_2$ *and* $\left((\hat{M}_{13})^{(1)}\right)_3$: 187

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$$\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[((\hat{Q}_{32})^{(6)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{32})^{(6)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{32})^{(6)}\right]\leq(\hat{Q}_{32})^{(6)}$$ 246

In order that the operator $\mathcal{A}^{(6)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself

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$$d\left(((G_{35})^{(1)},(T_{35})^{(1)}),((G_{35})^{(2)},(T_{35})^{(2)})\right)=$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}|G_i^{(1)}(t)-G_i^{(2)}(t)|e^{-(\hat{M}_{32})^{(6)}t},\max_{t\in\mathbb{R}_+}|T_i^{(1)}(t)-T_i^{(2)}(t)|e^{-(\hat{M}_{32})^{(6)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{35})},\widetilde{(T_{35})}$: $\left(\widetilde{(G_{35})},\widetilde{(T_{35})}\right)=\mathcal{A}^{(6)}((G_{35}),(T_{35}))$

It results

$$|\tilde{G}_{32}^{(1)}-\tilde{G}_i^{(2)}|\leq\int_0^t(a_{32})^{(6)}|G_{33}^{(1)}-G_{33}^{(2)}|e^{-(\hat{M}_{32})^{(6)}s_{(32)}}e^{(\hat{M}_{32})^{(6)}s_{(32)}}ds_{(32)}+$$

$$\int_0^t\{(a_{32}')^{(6)}|G_{32}^{(1)}-G_{32}^{(2)}|e^{-(\hat{M}_{32})^{(6)}s_{(32)}}e^{-(\hat{M}_{32})^{(6)}s_{(32)}}+$$

$$(a_{32}'')^{(6)}(T_{33}^{(1)},s_{(32)})|G_{32}^{(1)}-G_{32}^{(2)}|e^{-(\hat{M}_{32})^{(6)}s_{(32)}}e^{(\hat{M}_{32})^{(6)}s_{(32)}}+$$

$$G_{32}^{(2)}|(a_{32}'')^{(6)}(T_{33}^{(1)},s_{(32)})-(a_{32}'')^{(6)}(T_{33}^{(2)},s_{(32)})|\ e^{-(\hat{M}_{32})^{(6)}s_{(32)}}e^{(\hat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$$

Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,t]$

From the hypotheses it follows

$$|(G_{35})^{(1)}-(G_{35})^{(2)}|e^{-(\hat{M}_{32})^{(6)}t}\leq$$
$$\frac{1}{(\hat{M}_{32})^{(6)}}\left((a_{32})^{(6)}+(a_{32}')^{(6)}+(\hat{A}_{32})^{(6)}+(\hat{P}_{32})^{(6)}(\hat{k}_{32})^{(6)}\right)d\left(((G_{35})^{(1)},(T_{35})^{(1)};(G_{35})^{(2)},(T_{35})^{(2)})\right)$$ 248

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 26: The fact that we supposed $(a_{32}'')^{(6)}$ and $(b_{32}'')^{(6)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$ *and* $(\hat{Q}_{32})^{(6)}e^{(\hat{M}_{32})^{(6)}t}$ respectively of $\mathbb{R}_+$. 249

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(6)}$ and $(b_i'')^{(6)}, i=32,33,34$ depend only on T_{33} and respectively on

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$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[((\hat{Q}_{36})^{(7)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{36})^{(7)}\right] \leq (\hat{Q}_{36})^{(7)}$	257
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Remark 31: The fact that we supposed $(a''_{36})^{(7)}$ and $(b''_{36})^{(7)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$ *and* $(\hat{Q}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it	260

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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{Q}_{40})^{(8)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{40})^{(8)}\right] \leq (\hat{Q}_{40})^{(8)}$	268
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Remark 37 There does not exist any t where $G_i\,(t) = 0\ and\ T_i\,(t) = 0$ it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t\{(a_i')^{(8)}-(a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for $t > 0$	275
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$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b''_{42})^{(8)}\left((G_{43})(t), t(t), t\right) = (b'_{42})^{(8)}$	
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[(\widehat{P}_{44})^{(9)} + ((\widehat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}\left[((\widehat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{44})^{(9)}\right] \leq (\widehat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}\right), \left((G_{47})^{(2)}, (T_{47})^{(2)}\right)\right) = \sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\widehat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\widehat{M}_{44})^{(9)}t}\}$ Indeed if we denote **<u>Definition of</u>** $\widetilde{(G_{47})}, \widetilde{(T_{47})} : (\widetilde{(G_{47})}, \widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}), (T_{47}))$ It results $\lvert\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\rvert \leq \int_0^t (a_{44})^{(9)}\lvert G_{45}^{(1)} - G_{45}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} + \int_0^t\{(a'_{44})^{(9)}\lvert G_{44}^{(1)} - G_{44}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{-(\widehat{M}_{44})^{(9)}s_{(44)}} + (a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)})\lvert G_{44}^{(1)} - G_{44}^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}} + G_{44}^{(2)}\lvert(a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a''_{44})^{(9)}(T_{45}^{(2)}, s_{(44)})\rvert\; e^{-(\widehat{M}_{44})^{(9)}s_{(44)}}e^{(\widehat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$ Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, t]$ From the hypotheses on 45,46,47,28 and 29 it follows	
$\lvert(G_{47})^{(1)} - G^{(2)}\rvert e^{-(\widehat{M}_{44})^{(9)}t} \leq \frac{1}{(\widehat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)}(\widehat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; (G_{47})^{(2)}, (T_{47})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows	
<u>Remark 41:</u> The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by	

$(\widehat{P}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ *and* $(\widehat{Q}_{44})^{(9)}e^{(\widehat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on $(G_{47})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.	
Remark 42: There does not exist any t where $G_i(t) = 0\ and\ T_i(t) = 0$ From 99 to 44 it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)}t)} > 0$ for t > 0	
Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2\ and\ \left((\widehat{M}_{44})^{(9)}\right)_3$: **Remark 43:** if G_{44} is bounded, the same property have also $G_{45}\ and\ G_{46}$. indeed if $G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating $G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$ In the same way , one can obtain $G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$ If $G_{45}\ or\ G_{46}$ is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.	
Remark 44: If G_{44} *is* bounded, from below, the same property holds for $G_{45}\ and\ G_{46}$. The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.	
Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t), t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t), t) = (b_{46}')^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	

Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14}, t) + (a_{14}'')^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b_{13}')^{(1)} + (b_{14}')^{(1)} - (b_{13}'')^{(1)}(G, t) - (b_{14}'')^{(1)}(G, t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)}, \ if \ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if \ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)}, \ if \ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)}, \ if \ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if \ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)}$, and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if \ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation	285

$\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)}-(p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)}-(p_{13})^{(1)}-(S_2)^{(1)})}\left[e^{((S_1)^{(1)}-(p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq \right.$ $\left. \frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)}-(a_{15}')^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}')^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}')^{(1)}t}\right)$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
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$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
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$\frac{(a_{18})^{(2)}\mathrm{T}_{16}^{0}}{(\mu_2)^{(2)}((\mathrm{R}_1)^{(2)}+(r_{16})^{(2)}+(\mathrm{R}_2)^{(2)})}\left[\mathrm{e}^{((\mathrm{R}_1)^{(2)}+(r_{16})^{(2)})t}-\mathrm{e}^{-(\mathrm{R}_2)^{(2)}t}\right]+\mathrm{T}_{18}^{0}\mathrm{e}^{-(\mathrm{R}_2)^{(2)}t}$	
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Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$: $(\sigma_1)^{(3)},(\sigma_2)^{(3)},(\tau_1)^{(3)},(\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)}\le-(a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}-(a_{20}^{''})^{(3)}(T_{21},t)+(a_{21}^{''})^{(3)}(T_{21},t)\le-(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)}\le-(b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(b_{20}^{''})^{(3)}(G_{23},t)-(b_{21}^{''})^{(3)}((G_{23}),t)\le-(\tau_1)^{(3)}$	319
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and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \textbf{\textit{if}}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \textbf{\textit{if}}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \textbf{\textit{if}}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \le G_{20}(t) \le G_{20}^0 e^{(S_1)^{(3)} t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \le G_{21}(t) \le \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)} t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})} \left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)} t} \right] + G_{22}^0 e^{-(S_2)^{(3)} t} \le G_{22}(t) \le \right.$ $\left. \frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a'_{22})^{(3)})} \left[e^{(S_1)^{(3)} t} - e^{-(a'_{22})^{(3)} t} \right] + G_{22}^0 e^{-(a'_{22})^{(3)} t} \right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)} t} \le T_{20}(t) \le T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)} t} \le T_{20}(t) \le \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
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<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)} (m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)} (\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
<u>**Behavior of the solutions of equation**</u> <u>**Theorem:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \le -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \le -(\sigma_1)^{(4)}$	

$-(\tau_2)^{(4)} \leq -(b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (b_{24}^{''})^{(4)}\big((G_{27}),t\big) - (b_{25}^{''})^{(4)}\big((G_{27}),t\big) \leq -(\tau_1)^{(4)}$	
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and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)}, \ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}, \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)},$ and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
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$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334

$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	336
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\big((G_{31}), t\big) - (b_{29}'')^{(5)}\big((G_{31}), t\big) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\big(\nu^{(5)}\big)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\big(u^{(5)}\big)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\big(\nu^{(5)}\big)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\big(u^{(5)}\big)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,	340

and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}, \ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}^{'})^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}^{'})^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}^{'})^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
<u>**Definition of**</u> $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}^{'})^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}^{'})^{(5)}$ $(R_2)^{(5)} = (b_{30}^{'})^{(5)} - (r_{30})^{(5)}$	348
<u>**Behavior of the solutions of equation**</u>	349

Theorem 2: If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0, (\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0, (u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0, (\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0, (\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}, \ \boldsymbol{if} \ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}, \boldsymbol{if} \ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}, \ \boldsymbol{if} \ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}, \boldsymbol{if} \ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if} \ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353

$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ (a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t	355
$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the	362

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$	369

$\frac{(a_{38})^{(7)}T_{36}^{0}}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t}-e^{-(R_2)^{(7)}t}\right]+T_{38}^{0}e^{-(R_2)^{(7)}t}$	
Definition of $(S_1)^{(7)},(S_2)^{(7)},(R_1)^{(7)},(R_2)^{(7)}$:- Where $(S_1)^{(7)}=(a_{36})^{(7)}(m_2)^{(7)}-(a_{36}^{'})^{(7)}$ $(S_2)^{(7)}=(a_{38})^{(7)}-(p_{38})^{(7)}$ $(R_1)^{(7)}=(b_{36})^{(7)}(\mu_2)^{(7)}-(b_{36}^{'})^{(7)}$ $(R_2)^{(7)}=(b_{38}^{'})^{(7)}-(r_{38})^{(7)}$	370
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)},(\sigma_2)^{(8)},(\tau_1)^{(8)},(\tau_2)^{(8)}$: $(\sigma_1)^{(8)},(\sigma_2)^{(8)},(\tau_1)^{(8)},(\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)}\le-(a_{40}^{'})^{(8)}+(a_{41}^{'})^{(8)}-(a_{40}^{''})^{(8)}(T_{41},t)+(a_{41}^{''})^{(8)}(T_{41},t)\le-(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)}\le-(b_{40}^{'})^{(8)}+(b_{41}^{'})^{(8)}-(b_{40}^{''})^{(8)}\big((G_{43}),t\big)-(b_{41}^{''})^{(8)}\big((G_{43}),t\big)\le-(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)},(\nu_2)^{(8)},(u_1)^{(8)},(u_2)^{(8)},\nu^{(8)},u^{(8)}$: By $(\nu_1)^{(8)}>0,(\nu_2)^{(8)}<0$ and respectively $(u_1)^{(8)}>0,(u_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_1)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_1)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ and	372
Definition of $(\bar{\nu}_1)^{(8)},,(\bar{\nu}_2)^{(8)},(\bar{u}_1)^{(8)},(\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)}>0,(\bar{\nu}_2)^{(8)}<0$ and respectively $(\bar{u}_1)^{(8)}>0,(\bar{u}_2)^{(8)}<0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_2)^{(8)}\nu^{(8)}-(a_{40})^{(8)}=0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2+(\tau_2)^{(8)}u^{(8)}-(b_{40})^{(8)}=0$ **Definition of** $(m_1)^{(8)},(m_2)^{(8)},(\mu_1)^{(8)},(\mu_2)^{(8)},(\nu_0)^{(8)}$:- If we define $(m_1)^{(8)},(m_2)^{(8)},(\mu_1)^{(8)},(\mu_2)^{(8)}$ by $(m_2)^{(8)}=(\nu_0)^{(8)},(m_1)^{(8)}=(\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)}<(\nu_1)^{(8)}$	

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, ***if*** $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, ***if*** $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, ***if*** $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, ***if*** $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, ***if*** $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}')^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b_{42}')^{(8)}t}\right] + T_{42}^0 e^{-(b_{42}')^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>Definition of</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$	381

$(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \le -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \le -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \le -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \le -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)},$ $\boldsymbol{if}$ $(\nu_0)^{(9)} < (\nu_1)^{(9)}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)},$ $\boldsymbol{if}$ $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$, and $\boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}}$ $(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)},$ $\boldsymbol{if}$ $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$	
and analogously $(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)},$ $\boldsymbol{if}$ $(u_0)^{(9)} < (u_1)^{(9)}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)},$ $\boldsymbol{if}$ $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$, and $\boxed{(u_0)^{(9)} = \frac{T^0_{44}}{T^0_{45}}}$ $(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)},$ $\boldsymbol{if}$ $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively	

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)}-(p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t}\right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq \frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a'_{46})^{(9)})}\left[e^{(S_1)^{(9)}t} - e^{-(a'_{46})^{(9)}t}\right] + G_{46}^0 e^{-(a'_{46})^{(9)}t}\Big)$$

$$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b'_{46})^{(9)})}\left[e^{(R_1)^{(9)}t} - e^{-(b'_{46})^{(9)}t}\right] + T_{46}^0 e^{-(b'_{46})^{(9)}t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t}\right] + T_{46}^0 e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a'_{44})^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b'_{44})^{(9)}$

$(R_2)^{(9)} = (b'_{46})^{(9)} - (r_{46})^{(9)}$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a'_{13})^{(1)} - (a'_{14})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right) - (a''_{14})^{(1)}(T_{14}, t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right) t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right) t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right) t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right) t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right) t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right) t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right) t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right) t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right) t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right) t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u> If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)} + (\bar{C})^{(2)}(\bar{\nu}_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}{1 + (\bar{C})^{(2)} e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)} - (\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\bar{\nu}_2)^{(2)}}}$	391
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If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \ \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
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From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$	400

$$v^{(3)}(t) \geq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}}{1+(C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_0)^{(3)}\right)t\right]}} \quad , \quad \boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\nu_2)^{(3)}}}$$

it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$

In the same manner , we get 401

$$\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)}-(\nu_0)^{(3)}}{(\nu_0)^{(3)}-(\bar{\nu}_2)^{(3)}}}$$

<u>**Definition of**</u> $(\bar{\nu}_1)^{(3)}$:-

From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$

If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, 402

$$(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)}+(C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}}{1+(C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)}-(\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$$

If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain 403

$$(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)}+(\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}}{1+(\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)}-(\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$$

And so with the notation of the first part of condition (c) , we have

<u>**Definition of**</u> $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$ Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then $(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$	
Proof : From global equations we obtain $\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$ **Definition of** $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ It follows $-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:- For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$ $\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}$, $\boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$ it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$	404
In the same manner , we get $\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}$, $\boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$ From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	405
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$	407

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case** .

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

<u>Definition of</u> $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(5)}(t)$:-

$$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)}G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)}T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

<u>Proof</u> : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33},t)\right) - (a_{33}'')^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

<u>Definition of</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)\leq\frac{d\nu^{(6)}}{dt}\leq-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(6)},(\nu_0)^{(6)}$:- For $0<\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}<(\nu_1)^{(6)}<(\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t)\geq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)}=\frac{(\nu_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\nu_1)^{(6)}$	
In the same manner , we get $\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)}=\frac{(\bar{\nu}_1)^{(6)}-(\nu_0)^{(6)}}{(\nu_0)^{(6)}-(\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)}\leq\nu^{(6)}(t)\leq(\bar{\nu}_1)^{(6)}$	413
If $0<(\nu_1)^{(6)}<(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}<(\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)}\leq\frac{(\nu_1)^{(6)}+(C)^{(6)}(\nu_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}{1+(C)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)}-(\nu_2)^{(6)}\right)t\right]}}\leq\nu^{(6)}(t)\leq$ $\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\bar{\nu}_1)^{(6)}$	414
If $0<(\nu_1)^{(6)}\leq(\bar{\nu}_1)^{(6)}\leq\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)}\leq\nu^{(6)}(t)\leq\frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}\leq(\nu_0)^{(6)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(6)}(t)$:- $(m_2)^{(6)}\leq\nu^{(6)}(t)\leq(m_1)^{(6)},\quad\boxed{\nu^{(6)}(t)=\frac{G_{32}(t)}{G_{33}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(6)}(t)$:- $(\mu_2)^{(6)}\leq u^{(6)}(t)\leq(\mu_1)^{(6)},\quad\boxed{u^{(6)}(t)=\frac{T_{32}(t)}{T_{33}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	415

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)} e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 418

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	
If $0<(\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)},\ \boxed{\nu^{(7)}(t)=\frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)},\ \boxed{u^{(7)}(t)=\frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)}=(a''_{37})^{(7)}, then\ (\sigma_1)^{(7)}=(\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)}=(\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)}=(\nu_1)^{(7)}$ then $\nu^{(7)}(t)=(\nu_0)^{(7)}$ and as a consequence $G_{36}(t)=(\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)}=(b''_{37})^{(7)}, then\ (\tau_1)^{(7)}=(\tau_2)^{(7)}$ and then $(u_1)^{(7)}=(\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)}=(u_1)^{(7)}$ then $T_{36}(t)=(u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420
Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt}=(a_{40})^{(8)}-\left((a'_{40})^{(8)}-(a'_{41})^{(8)}+(a''_{40})^{(8)}(T_{41},t)\right)-(a''_{41})^{(8)}(T_{41},t)\nu^{(8)}-(a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)}=\frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_2)^{(8)}\nu^{(8)}-(a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2+(\sigma_1)^{(8)}\nu^{(8)}-(a_{40})^{(8)}\right)$	421

From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)}-(\nu_0)^{(8)}}{(\nu_0)^{(8)}-(\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)}+(C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)}-(\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:- $(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(8)}(t)$:- $(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	424

Particular case : If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .** Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$**, and definition of** $(u_0)^{(8)}$.	
Proof : From 99,20,44,22,23,44 we obtain $$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$ **Definition of** $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$ It follows $$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:- For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$ $$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$ it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$	424 A
In the same manner , we get $$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$ From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$	
If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case, $$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$ $$\frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$	

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right) t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right) t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case** .

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$ if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

with $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system

Theorem : If $(a''_i)^{(2)} and\ (b''_i)^{(2)}$ are independent on t , and the conditions with the notations 426

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$ 427

$(a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a'_{17})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$ 428

$(b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$, 429

$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)}-(b_{16})^{(2)}(b_{17})^{(2)}-(b_{16}^{'})^{(2)}(r_{17})^{(2)}-(b_{17}^{'})^{(2)}(r_{17})^{(2)}+(r_{16})^{(2)}(r_{17})^{(2)}<0$ $with\ (p_{16})^{(2)},(r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}<0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)}-(a_{20})^{(3)}(a_{21})^{(3)}+(a_{20})^{(3)}(p_{20})^{(3)}+(a_{21}^{'})^{(3)}(p_{21})^{(3)}+(p_{20})^{(3)}(p_{21})^{(3)}>0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}>0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-(b_{20}^{'})^{(3)}(r_{21})^{(3)}-(b_{21}^{'})^{(3)}(r_{21})^{(3)}+(r_{20})^{(3)}(r_{21})^{(3)}<0$ $with\ (p_{20})^{(3)},(r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}<0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)}-(a_{24})^{(4)}(a_{25})^{(4)}+(a_{24})^{(4)}(p_{24})^{(4)}+(a_{25}^{'})^{(4)}(p_{25})^{(4)}+(p_{24})^{(4)}(p_{25})^{(4)}>0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}>0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-(b_{24}^{'})^{(4)}(r_{25})^{(4)}-(b_{25}^{'})^{(4)}(r_{25})^{(4)}+(r_{24})^{(4)}(r_{25})^{(4)}<0$ $with\ (p_{24})^{(4)},(r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}<0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)}-(a_{28})^{(5)}(a_{29})^{(5)}+(a_{28})^{(5)}(p_{28})^{(5)}+(a_{29}^{'})^{(5)}(p_{29})^{(5)}+(p_{28})^{(5)}(p_{29})^{(5)}>0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}>0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-(b_{28}^{'})^{(5)}(r_{29})^{(5)}-(b_{29}^{'})^{(5)}(r_{29})^{(5)}+(r_{28})^{(5)}(r_{29})^{(5)}<0$ $with\ (p_{28})^{(5)},(r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}<0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)}-(a_{32})^{(6)}(a_{33})^{(6)}+(a_{32})^{(6)}(p_{32})^{(6)}+(a_{33}^{'})^{(6)}(p_{33})^{(6)}+(p_{32})^{(6)}(p_{33})^{(6)}>0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}>0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-(b_{32}^{'})^{(6)}(r_{33})^{(6)}-(b_{33}^{'})^{(6)}(r_{33})^{(6)}+(r_{32})^{(6)}(r_{33})^{(6)}<0$	434

$with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ \ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	436 A
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440

$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)\ ]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)\ ]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)\ ]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	

$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\ ]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\ ]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\ ]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\ ]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\ ]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\ ]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478

$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\,]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\,]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\,]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\,]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\,]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\,]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (ff) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) + (a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	486
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof:	488

(a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A
Definition and uniqueness of T^*_{14} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T^*_{14} for which $f(T^*_{14}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$	493
Definition and uniqueness of T^*_{17} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(2)}(T_{17})$ being increasing, it follows that	494

there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{16} = \frac{(a_{16})^{(2)} G_{17}}{[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17}^{*})]} \quad , \quad G_{18} = \frac{(a_{18})^{(2)} G_{17}}{[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}^{*})]}$$ 495

Definition and uniqueness of T_{21}^{*} :- 496

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21}^{*})]} \quad , \quad G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}^{*})]}$$

Definition and uniqueness of T_{25}^{*} :- 497

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^{*})]} \quad , \quad G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^{*})]}$$

Definition and uniqueness of T_{29}^{*} :- 498

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]} \quad , \quad G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$$

Definition and uniqueness of T_{33}^{*} :- 499

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]} \quad , \quad G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$$

Definition and uniqueness of T_{37}^{*} :- 500

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]} \quad , \quad G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$$

Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right] + (b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right] + (b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505

By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26})$, G_{24}, G_{26} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{25} such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30})$, G_{28}, G_{30} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{29} such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34})$, G_{32}, G_{34} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{33} such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38})$, G_{36}, G_{38} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{37} such that $\varphi(G_{39}{}^*) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42})$, G_{40}, G_{42} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$	

Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)} G_{14}^*}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)} G_{14}^*}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)} T_{14}^*}{[(b_{13}')^{(1)} - (b_{13}'')^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)} T_{14}^*}{[(b_{15}')^{(1)} - (b_{15}'')^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)} G_{17}^*}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)} G_{17}^*}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)} T_{17}^*}{[(b_{16}')^{(2)} - (b_{16}'')^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)} T_{17}^*}{[(b_{18}')^{(2)} - (b_{18}'')^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)} G_{21}^*}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)} G_{21}^*}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)} T_{21}^*}{[(b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)} T_{21}^*}{[(b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515
Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution	518

G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	523
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$	523 A

$T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}')^{(9)} - (b_{44}'')^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}')^{(9)} - (b_{46}'')^{(9)}((G_{47})^*)]}$	
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(1)}$ *and* $(b_i'')^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}'')^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i'')^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}')^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}')^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}')^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}')^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}')^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}')^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	531
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)}$, $\frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^* \mathbb{T}_{17}$	534

$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^{*}\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^{*}\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^{*}\mathbb{G}_{j}\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^{*}\mathbb{G}_{j}\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^{*}\mathbb{G}_{j}\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^{*}) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}\left((G_{23})^{*}\right) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_{j}\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_{j}\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_{j}\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	547
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:-	548

$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$	
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b''_i)^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562

ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ and $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}} (T_{33}^*) = (q_{33})^{(6)}$, $\frac{\partial (b_i^{''})^{(6)}}{\partial G_j} ((G_{35})^*) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)} G_{32}^* \mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)} G_{33}^* \mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)} G_{34}^* \mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)} T_{32}^* \mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)} T_{33}^* \mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)} T_{34}^* \mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ and $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}^{''})^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)}$, $\frac{\partial (b_i^{''})^{(7)}}{\partial G_j} ((G_{39})^{**}) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G_{36}^* \mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}^{'})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G_{37}^* \mathbb{T}_{37}$	574

$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}^{'})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^{*}\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^{*}\mathbb{G}_{j}\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}^{'})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^{*}\mathbb{G}_{j}\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^{*}\mathbb{G}_{j}\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}$ *and* $(b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^{*}) = (q_{41})^{(8)} \quad , \frac{\partial (b_i^{''})^{(8)}}{\partial G_j}((G_{43})^{*}) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^{*}\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^{*}\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	586 A

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}'')^{(9)}}{\partial T_{45}} (T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i'')^{(9)}}{\partial G_j} ((G_{47})^*) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}')^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)} G_{44}^* \mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}')^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)} G_{45}^* \mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}')^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)} G_{46}^* \mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}')^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)} T_{44}^* \mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}')^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)} T_{45}^* \mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}')^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)} T_{46}^* \mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}')^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}')^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}')^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^* + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^* + (b_{14})^{(1)}s_{(13),(13)}T_{13}^*\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$ $+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$ $+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$ +	

$$((\lambda)^{(2)} + (b'_{18})^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a'_{18})^{(2)} + (p_{18})^{(2)})$$

$$\left[\left(((\lambda)^{(2)} + (a'_{16})^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}^*_{17} + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}^*_{16}\right)\right]$$

$$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}^*_{17}\right)$$

$$+\left(((\lambda)^{(2)} + (a'_{17})^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}^*_{16} + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}^*_{17}\right)$$

$$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}^*_{16}\right)$$

$$\left(((\lambda)^{(2)})^2 + \left((a'_{16})^{(2)} + (a'_{17})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$\left(((\lambda)^{(2)})^2 + \left((b'_{16})^{(2)} + (b'_{17})^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$$

$$+\left(((\lambda)^{(2)})^2 + \left((a'_{16})^{(2)} + (a'_{17})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+((\lambda)^{(2)} + (a'_{16})^{(2)} + (p_{16})^{(2)})\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}^*_{17} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}^*_{16}\right)$$

$$\left(((\lambda)^{(2)} + (b'_{16})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}^*_{17} + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}^*_{16}\right)\} = 0$$

$+$

$$((\lambda)^{(3)} + (b'_{22})^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a'_{22})^{(3)} + (p_{22})^{(3)})$$

$$\left[\left(((\lambda)^{(3)} + (a'_{20})^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G^*_{21} + (a_{21})^{(3)}(q_{20})^{(3)}G^*_{20}\right)\right]$$

$$\left(((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T^*_{21} + (b_{21})^{(3)}s_{(20),(21)}T^*_{21}\right)$$

$$+\left(((\lambda)^{(3)} + (a'_{21})^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G^*_{20} + (a_{20})^{(3)}(q_{21})^{(1)}G^*_{21}\right)$$

$$\left(((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T^*_{21} + (b_{21})^{(3)}s_{(20),(20)}T^*_{20}\right)$$

$$\left(((\lambda)^{(3)})^2 + \left((a'_{20})^{(3)} + (a'_{21})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$\left(((\lambda)^{(3)})^2 + \left((b'_{20})^{(3)} + (b'_{21})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$$

$$+\left(((\lambda)^{(3)})^2 + \left((a'_{20})^{(3)} + (a'_{21})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$$

$$+((\lambda)^{(3)} + (a'_{20})^{(3)} + (p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G^*_{21} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G^*_{20}\right)$$

$$\left(((\lambda)^{(3)} + (b'_{20})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(22)}T^*_{21} + (b_{21})^{(3)}s_{(20),(22)}T^*_{20}\right)\} = 0$$

$+$

$((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(((\lambda)^{(4)})^{2} + ((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)})(\lambda)^{(4)}\right)$ $\left(((\lambda)^{(4)})^{2} + ((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)})(\lambda)^{(4)}\right)$ $+\left(((\lambda)^{(4)})^{2} + ((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)})(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$ $\left(((\lambda)^{(5)})^{2} + ((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)})(\lambda)^{(5)}\right)$ $\left(((\lambda)^{(5)})^{2} + ((b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)})(\lambda)^{(5)}\right)$ $+\left(((\lambda)^{(5)})^{2} + ((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)})(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$ $+((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(30)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\} = 0$ +	

$$((\lambda)^{(6)} + (b_{34}^{'})^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a_{34}^{'})^{(6)} + (p_{34})^{(6)})$$

$$\left[\left(((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)})(q_{33})^{(6)}G_{33}^{*} + (a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)})s_{(33),(33)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(((\lambda)^{(6)} + (a_{33}^{'})^{(6)} + (p_{33})^{(6)})(q_{32})^{(6)}G_{32}^{*} + (a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)})s_{(33),(32)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(((\lambda)^{(6)})^{2} + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$\left(((\lambda)^{(6)})^{2} + \left((b_{32}^{'})^{(6)} + (b_{33}^{'})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$+\left(((\lambda)^{(6)})^{2} + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)})\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)})s_{(33),(34)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(7)} + (b_{38}^{'})^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a_{38}^{'})^{(7)} + (p_{38})^{(7)})$$

$$\left[\left(((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)})(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)})s_{(37),(37)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(((\lambda)^{(7)} + (a_{37}^{'})^{(7)} + (p_{37})^{(7)})(q_{36})^{(7)}G_{36}^{*} + (a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)})s_{(37),(36)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(((\lambda)^{(7)})^{2} + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(((\lambda)^{(7)})^{2} + \left((b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(((\lambda)^{(7)})^{2} + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)})\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)})s_{(37),(38)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\} = 0$$

$+$

$((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)})$

$\left[\left(((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(((\lambda)^{(8)})^{2} + ((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})\ (\lambda)^{(8)}\right)$

$\left(((\lambda)^{(8)})^{2} + ((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)})\ (\lambda)^{(8)}\right)$

$+\left(((\lambda)^{(8)})^{2} + ((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)})\ (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})\ ((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*})$

$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$

$+$

$((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)})$

$\left[\left(((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(44)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(((\lambda)^{(9)})^{2} + ((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})\ (\lambda)^{(9)}\right)$

$\left(((\lambda)^{(9)})^{2} + ((b_{44}^{'})^{(9)} + (b_{45}^{'})^{(9)} - (r_{44})^{(9)} + (r_{45})^{(9)})\ (\lambda)^{(9)}\right)$

$+\left(((\lambda)^{(9)})^{2} + ((a_{44}^{'})^{(9)} + (a_{45}^{'})^{(9)} + (p_{44})^{(9)} + (p_{45})^{(9)})\ (\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})\ ((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*})$

$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(46)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\} = 0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and

this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION THIRTY TWO

Supersymmetric Yang–Mills Quantum Mechanics

INTRODUCTION—VARIABLES USED

Wess–Zumino model from Wikipedia, the free encyclopedia

(1) In theoretical physics, the Wess–Zumino model has become the first known example of an interacting four-dimensional quantum field theory with (e&eb) supersymmetry.

(2) In 1974, Julius Wess and Bruno Zumino studied, using modern terminology, dynamics of a single chiral superfield (composed of a complex scalar and a spinor fermion) whose cubic superpotential leads to (eb) a renormalizable theory.

(3) The Lagrangian of the free massless Wess–Zumino model in four-dimensional spacetime with flat metric \mathrm{diag}(-1,1,1,1) is \mathcal{L}=-\frac{1}{2}(\partial S)^{2}-\frac{1}{2}(\partial P)^{2}-\frac{1}{2}\bar{\psi} \partial\!\!\!/ \psi with S a scalar field, P a pseudoscalar field and \psi a Majorana spinor field. The action is invariant under the transformations generated by the superalgebra. The infinitesimal form of these transformations is:

(i) \delta_{\epsilon} S=\bar{\epsilon} \psi $\delta_\epsilon S = \bar{\epsilon}\psi$

(ii) \delta_{\epsilon} P =\bar{\epsilon} \gamma_{5} \psi $\delta_\epsilon P = \bar{\epsilon}\gamma_5\psi$

(iii) \delta_{\epsilon} \psi =\partial\!\!\!/ (S+P\gamma_{5})\epsilon $\delta_\epsilon \psi = \partial\!\!\!/(S + P\gamma_5)\epsilon$

Here \epsilon is a Majorana spinor-valued transformation parameter and \gamma_{5} is the chirality operator.

(4) Invariance under a (modified) set of supersymmetry transformations remains if (e) one adds mass terms for the fields provided (e) the masses are equal.

(5) It is also possible to add interaction terms under (e&eb) some algebraic conditions on the coupling constants, resulting from (e) the fact that the interactions come from (e) superpotential for (e) the chiral superfield containing (e) the fields S, P and \psi.

Wess–Zumino–Witten model from Wikipedia, the free encyclopedia. Note that the model holds for the following propositions too. We have not dilated at length as has been under other section due to restrictions on space.

(1) In theoretical physics and mathematics, the Wess–Zumino–Witten (WZW) model, also called

the Wess–Zumino–Novikov–Witten model, is a simple model of conformal field theory whose solutions are realized by (e) affine Kac–Moody algebras. It is named after Julius Wess, Bruno Zumino, Sergei Novikov and Edward Witten. [1] [2] [3] [4]

Action

(2) Let G denote a compact simply-connected Lie group and g its simple Lie algebra. Suppose that γ is a G-valued field on the complex plane. More precisely, we want γ to be defined on theRiemann sphere S ², which amounts to the complex plane compactified by adding a point at infinity.

(3) The WZW model is then a nonlinear sigma model defined by γ with an action given by

$$S_k(\gamma) = -\frac{k}{8\pi}\int_{S^2} d^2x\,\mathcal{K}(\gamma^{-1}\partial^\mu\gamma\,,\,\gamma^{-1}\partial_\mu\gamma) + 2\pi k\,S^{\mathrm{WZ}}(\gamma).$$

(4) Here, ∂μ = ∂/∂xμ is the partial derivative and the usual summation convention over (e&eb) indices is used, with a Euclidean metric.

(5) Here, $\mathcal{K}$ is the Killing form on (e &eb) g, and thus the first term is (=) the standard kinetic term of quantum field theory.

(6) The term SWZ is called the Wess–Zumino term and can be written as

$$S^{\mathrm{WZ}}(\gamma) = -\frac{1}{48\pi^2}\int_{B^3} d^3y\,\epsilon^{ijk}\mathcal{K}\left(\gamma^{-1}\frac{\partial\gamma}{\partial y^i}\,,\,\left[\gamma^{-1}\frac{\partial\gamma}{\partial y^j}\,,\,\gamma^{-1}\frac{\partial\gamma}{\partial y^k}\right]\right)$$

(7) Here [,] is the commutator, εijk is the completely anti-symmetric tensor, and the integration coordinates yi for i=1, 2, 3 range over (e&eb) the unit ball B ³. In this integral, the field γ has been extended so that it is defined on (e&eb) the interior of the unit ball.

(8) This extension can always be done because (e) the homotopy group π2 (G) always vanishes for (e) any compact, simply-connected Lie group, and we originally defined γ on the 2-sphere S ² = ∂B ³.

Pullback

(9) Note that if ea are the basis vectors for the Lie algebra, (eb) then $\mathcal{K}(e_a, [e_b, e_c])$ are the structure constants of the Lie algebra.

(10) Note also that the structure constants are (=) completely anti-symmetric, and thus they define (eb) a 3-form on (e&eb) the group manifold of G.

(11) Thus, the integrand above is just the pullback of (e) the harmonic 3-form to the ball B ³. Denoting the harmonic 3-form by c and the pullback by γ*, one then has

$$S^{\mathrm{WZ}}(\gamma) = \int_{B^3}\gamma^* c.$$

(12) This form leads directly to (E&EB)a topological analysis of the WZ term.

(13) Geometrically, this term describes the torsion of the respective manifold.[5] The presence of this torsion compels teleparallelism of the manifold, and thus trivialization of the torsionful curvature tensor; and hence arrest of the renormalization flow, an infrared fixed point of the renormalization group, a phenomenon termed geometrostasis.

Topological obstructions

(14) The extension of the field to the interior of the ball is not unique; the need that the physics be independent of the extension imposes a quanitization condition on the coupling parameter k, thelevel. Consider two different extensions of γ to the interior of the ball. They are maps from flat 3-space into the Lie group G. Consider now glueing these two balls together at their boundaryS^2. The result of the gluing is a topological 3-sphere; each ball B^3 is a hemisphere of S^3. The two different extensions of γ on each ball now become a map $S^3 \to G$. However, the homotopy group $\pi3 (G) = \mathbb{Z}$ for any compact, connected simple Lie group G.

Thus, one has

$$S^{\mathrm{WZ}}(\gamma) = S^{\mathrm{WZ}}(\gamma') + n \ ,$$

where γ and γ' denote the two different extensions onto the ball, and n, an integer, is the winding number of the glued-together map.

The physics that this model leads to will stay the same if

$$\exp\left(i2\pi k S^{\mathrm{WZ}}(\gamma)\right) = \exp\left(i2\pi k S^{\mathrm{WZ}}(\gamma')\right) \ .$$

(15) Thus, topological considerations lead one to conclude that the level k must be an integer when G is a connected, compact, simple Lie group. For a semisimple or disconnected compact Lie group, the level consists of an integer for each connected, simple component.

(16) This topological obstruction can also be seen in the representation theory of the affine Lie algebra symmetry of the theory.

(17) When each level is a positive integer the affine Lie algebra has unitary highest weight representations with highest weights that are dominant integral.

(18) Such representations are easier to work with as they decompose into finite-dimensional subalgebras with respect to the subalgebras spanned by each simple root, the corresponding negative root and their commutator, which is a Cartan generator.

(19) Often one is interested in a WZW model with a noncompact simple Lie group G, such as $SL(2,\mathbb{R})$ which has been used by Juan Maldacena and Hirosi Ooguri to describe string theory on a three-dimensional anti-de Sitter space,[6] which is the universal cover of the group $SL(2,\mathbb{R})$. In this case, as $\pi3\ (SL\ (2,\ \mathbb{R})) = 0$, there is no topological obstruction and the level need not be integral. Correspondingly, the representation theory of such noncompact Lie groups is much richer than that of their compact counterparts.

Generalizations

(20) Although in the above, the WZW model is defined on (e&eb) the Riemann sphere, it can be generalized so that the field γ lives on a compact Riemann surface.

Current algebra

(21) The current algebra of the WZW model is a Kac–Moody algebra. The stress energy tensor is given by the Sugawara construction.

Coset construction

(22) Taking the quotient of two WZW models gives a new conformal field theory whose central charge is the difference of the two original ones.

Nuclear Physics B Volume 644, Issues 1–2, 11 November 2002, Pages 85–112 Spectra of supersymmetric Yang–Mills quantum mechanics. Wosiek

(1) The new method of solving quantum mechanical problems is proposed. The finite, i.e., cut-off, Hilbert space is algebraically implemented in (e&eb) the computer code with (e&eb) states represented by (e) lists of variable length.
(2) Complete numerical solution of a given system is then automatically obtained. The technique is applied to (e&eb) Wess–Zumino quantum mechanics and D=2 and D=4 supersymmetric Yang–Mills quantum mechanics with (e&eb) SU (2) gauge group.
(3) Convergence with increasing cut-off was observed in (eb) many cases well within the reach of present machines.
(4) Many old results were confirmed and some new ones, especially for the D=4 system, are (=) derived. Extension to D=10 is possible but computationally demanding for higher gauge groups

Superconformal multi-black hole quantum mechanics Jeremy Michelson1,2 and Andrew Strominger2 Published 15 September 1999 • Journal of High Energy Physics, Volume 1999, JHEP09(1999)

(5) The quantum mechanics of (e) N slowly-moving charged BPS black holes in (eb) five-dimensional Script N = 1 supergravity is considered.
(6) The moduli space metric of (e) the N black holes is derived and shown to admit (e) 4 supersymmetries.
(7) A near-horizon limit is found in which the dynamics of widely separated black holes decouples (e&eb) from that of strongly-interacting, near-coincident black holes.
(8) This decoupling suggests (eb) that the quantum states supported in (eb) the near-horizon moduli space can be interpreted as (=) internal states of a single composite black hole carrying (e&eb)all of the charge.
(9) The near-horizon theory is shown to have (e) an enhanced D (2, 1; 0) superconformal symmetry.
(10) Eigenstates of the Hamiltonian H of the near-horizon theory are (=) ill-defined due to (e) noncompact regions of (e) the moduli space corresponding to (e) highly redshifted near-coincident black holes.
(11) It is argued that one should consider, instead of H eigenstates, eigenstates of (e) 2L0 = H+K, where (e) K is the generator of special conformal transformations.
(12) The result is a well defined Hilbert space with (e&eb) a discrete spectrum describing the N-black hole dynamics.

NOTATION

Module One

The new method of solving quantum mechanical problems is proposed.

The finite, i.e., **cut-off, Hilbert space is algebraically implemented** in (e&eb) the computer code with (e&eb) states represented by (e) lists of variable length.

G_{13} : Category one of **cut-off, Hilbert space is algebraically implemented;** computer code with (e&eb)

states represented by (e) lists of variable length. G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of computer code with (e&eb) states represented by lists of variable length; **cut-off, Hilbert space is algebraically implemented** T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two The finite, i.e., cut-off, Hilbert space is algebraically implemented in the computer code with states represented by lists of variable length	
G_{16} : Category one of **cut-off, Hilbert space is algebraically implemented in the computer code;** states represented by lists of variable length G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of states represented by lists of variable length; **cut-off, Hilbert space is algebraically implemented in the computer code** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three Complete numerical solution of a given system is then automatically obtained. The technique is applied to (e&eb) Wess–Zumino quantum mechanics and D=2 and D=4 supersymmetric Yang–Mills quantum mechanics with (e&eb) SU (2) gauge group	
G_{20} : Category one of **Complete numerical solution of a given system;** Wess–Zumino quantum mechanics and D=2 and D=4 supersymmetric Yang–Mills quantum mechanics with (e&eb) SU (2) gauge group G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of Wess–Zumino quantum mechanics and D=2 and D=4 supersymmetric Yang–Mills quantum mechanics with (e&eb) SU (2) gauge group **;Complete numerical solution of a given system** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four The technique of Complete numerical solution of a given system is applied to Wess–Zumino quantum mechanics and D=2 and D=4 supersymmetric Yang–Mills quantum mechanics with (e&eb) SU (2) gauge	

group	
G_{24} : Category one of **technique of Complete numerical solution of a given system is applied to Wess–Zumino quantum mechanics and D=2 and D=4 supersymmetric Yang–Mills quantum mechanics;** SU (2) gauge group G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of SU (2) gauge group; **technique of Complete numerical solution of a given system is applied to Wess–Zumino quantum mechanics and D=2 and D=4 supersymmetric Yang–Mills quantum mechanics** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Convergence with increasing cut-off was observed in (eb) many cases well within the reach of present machines	
G_{28} : Category one of **Convergence with increasing cut-off;** many cases well within the reach of present machines G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of many cases well within the reach of present machines **;Convergence with increasing cut-off** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six Many old results were confirmed and some new ones, especially for the D=4 system, are (=) derived. Extension to D=10 is possible but computationally demanding for higher gauge groups	
G_{32} : Category one of higher gauge groups G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of Extension to D=10 is possible but computationally demanding T_{33} : Category two of SAS T_{34} : Category three of SAS	

Module seven The quantum mechanics of (e) N slowly-moving charged BPS black holes in (eb) five-dimensional Script N = 1 supergravity is considered	
G_{36} : Category one of N slowly-moving charged BPS black holes in (eb) five-dimensional Script N = 1 supergravity is considered G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of quantum mechanics T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight The quantum mechanics of N slowly-moving charged BPS black holes in (eb) five-dimensional Script N = 1 supergravity is considered	
G_{40} : Category one of quantum mechanics of N slowly-moving charged BPS black holes G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of five-dimensional Script N = 1 supergravity T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine The moduli space metric of the N black holes is derived and shown to admit (e) 4 supersymmetries	
G_{44} : Category one of4 supersymmetries G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of moduli space metric of the N black holes T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	

$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t) \right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t) \right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t) \right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t) \right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t) \right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t) \right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}, t) \right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}, t) \right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}, t) \right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}), t \right) \right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}), t \right) \right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}), t \right) \right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}), t \right) =$ First detritions factor	
Module Numbered Three	

The differential system of this model is now (Module numbered three)	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)} G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)} (T_{21}, t) \right] G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)} G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)} (T_{21}, t) \right] G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)} G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)} (T_{21}, t) \right] G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)} T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)} (G_{23}, t) \right] T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)} T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)} (G_{23}, t) \right] T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)} (G_{23}, t) \right] T_{22}$	18
$+(a''_{20})^{(3)} (T_{21}, t) =$ First augmentation factor	
$-(b''_{20})^{(3)} (G_{23}, t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)} (T_{25}, t) \right] G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)} (T_{25}, t) \right] G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)} (T_{25}, t) \right] G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)} T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)} ((G_{27}), t) \right] T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)} T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)} ((G_{27}), t) \right] T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)} T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)} ((G_{27}), t) \right] T_{26}$	24
$+(a''_{24})^{(4)} (T_{25}, t) =$ **First augmentation factor**	
$-(b''_{24})^{(4)} ((G_{27}), t) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)} G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)} (T_{29}, t) \right] G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)} (T_{29}, t) \right] G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)} (T_{29}, t) \right] G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)} ((G_{31}), t) \right] T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)} ((G_{31}), t) \right] T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)} ((G_{31}), t) \right] T_{30}$	30
$+(a''_{28})^{(5)} (T_{29}, t) =$ **First augmentation factor**	
$-(b''_{28})^{(5)} ((G_{31}), t) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)} (T_{33}, t) \right] G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)} (T_{33}, t) \right] G_{33}$	32

$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right)\right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\left((G_{35}),t\right)\right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\left((G_{35}),t\right)\right] T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\left((G_{39}),t\right)\right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\left((G_{39}),t\right)\right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\left((G_{39}),t\right)\right] T_{38}$	*42*
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right] G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}),t\right)\right] T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}),t\right)\right] T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}),t\right)\right] T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right] T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	

$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \right] G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \right] G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \right] G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \right] T_{15}$	60

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{16} \quad 61$$

$$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{17} \quad 62$$

$$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix} \right] G_{18} \quad 63$$

Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation

coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16} \quad (64)$$

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17} \quad (65)$$

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18} \quad (66)$$

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{20}$$	67
$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{21}$$	68
$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{matrix} \right] G_{22}$$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3	
$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{20}$$	70
$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{21}$$	71

$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22}$	72
$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3* $\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24}$	73
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25}$	74
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26}$	75
$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1, 2\ \ 3$ $\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ $are\ second\ augmentation\ coefficient\ for\ category\ 1, 2\ and\ 3$ $\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category\ 1, 2\ and\ 3$	

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$
are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$
are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$
are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$
are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$
are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$
are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$
are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$
are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$
are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$
are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} \boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$	83

$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$	85
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$	86
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation*	

$coefficients\ for\ category\ 1, 2\ and\ 3$	
$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients	
$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients	
$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients	
$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients	
$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients	
$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32}$$	88
$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$$	89
$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ $are\ first\ detrition\ coefficients\ for\ category\ 1, 2\ and\ 3$ $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ $are\ second\ detrition\ coefficients\ for\ category\ 1, 2\ and\ 3$ $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ $are\ third\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$ $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3	

$-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)$ are eighth detrition coefficients for category 1, 2, and 3 $-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[\begin{matrix} (a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t) + (a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t) + (a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t) + (a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t) + (a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{matrix} \right] G_{13}$	*91*
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[\begin{matrix} (a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t) + (a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t) + (a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t) + (a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{matrix} \right] G_{14}$	*92*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[\begin{matrix} (a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t) + (a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t) + (a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t) \\ +(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t) + (a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t) \end{matrix} \right] G_{15}$	*93*
Where $(a''_{36})^{(7)}(T_{37},t)$, $(a''_{37})^{(7)}(T_{37},t)$, $(a''_{38})^{(7)}(T_{37},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)$ are eighth augmentation coefficient for 1,2,3 $+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} =$	94

$$(b_{36})^{(7)}T_{37} - \left[\begin{matrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$

$$\frac{dT_{37}}{dt} =$$

$$(b_{37})^{(7)}T_{36} - \left[\begin{matrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$

$$\frac{dT_{38}}{dt} =$$

$$(b_{38})^{(7)}T_{37} - \left[\begin{matrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$$

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$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} & \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i^{''})^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i^{''})^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b_i^{'})^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2 \to \infty} (a_i^{''})^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b_i^{''})^{(1)} (G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\lvert(a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\rvert \le (\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\ ,\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)},\ (r_i)^{(1)},i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[\,(a_i)^{(1)}+(a_i')^{(1)}+\ (\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}\,(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[\,(b_i)^{(1)}+(b_i')^{(1)}+\ (\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}\ (\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0,\quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)},\ (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t)\le(p_i)^{(2)}\le\left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t)\le\ (r_i)^{(2)}\le(b_i')^{(2)}\le(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}\,(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}\left((G_{19}),t\right)=\ (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)}$ are positive constants and $i=16,17,18$	106
They satisfy Lipschitz condition:	

$\lvert(a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)}+(a_i')^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i')^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)},\ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21},t)\leq(p_i)^{(3)}\leq(\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t)\leq\ (r_i)^{(3)}\leq(b_i')^{(3)}\leq(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}\ (T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}\ (G_{23},t)=\ \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}$ are positive constants and $i=20,21,22$	113

They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21}-T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}',t)-(b_i'')^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23}-G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and $(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}$, $\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}}<1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[\,(a_i)^{(3)}+(a_i')^{(3)}+\ (\hat{A}_{20})^{(3)}+\ (\hat{P}_{20})^{(3)}\,(\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[\,(b_i)^{(3)}+(b_i')^{(3)}+\ (\hat{B}_{20})^{(3)}+\ (\hat{Q}_{20})^{(3)}\ (\hat{k}_{20})^{(3)}]<1$	116
Where we suppose	
$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)}>0,\quad i,j=24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t)\leq(p_i)^{(4)}\leq(\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t)\leq\ (r_i)^{(4)}\leq(b_i')^{(4)}\leq(\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t)=\ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}$ are positive constants and $i=24,25,26$	118
They satisfy Lipschitz condition:	119

$\lvert(a_i'')^{(4)}(T_{25}',t)-(a_i'')^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i'')^{(4)}((G_{27})',t)-(b_i'')^{(4)}\big((G_{27}),t\big)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and$(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $\big[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}\big]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
<u>Definition of</u> $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(p_i)^{(4)},\ (r_i)^{(4)},i=24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\,(a_i)^{(4)}+(a_i')^{(4)}+\ (\hat{A}_{24})^{(4)}+\ (\hat{P}_{24})^{(4)}\,(\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)}+(b_i')^{(4)}+\ (\hat{B}_{24})^{(4)}+\ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i')^{(5)},(a_i'')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(b_i'')^{(5)}>0,\quad i,j=28,29,30$ The functions $(a_i'')^{(5)},(b_i'')^{(5)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(5)},\ \ (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t)\leq(p_i)^{(5)}\leq(\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}\big((G_{31}),t\big)\leq\ (r_i)^{(5)}\leq(b_i')^{(5)}\leq(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t)=\ (r_i)^{(5)}$ **<u>Definition of</u>** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ \ (r_i)^{(5)}$ are positive constants and $i=28,29,30$	123

They satisfy Lipschitz condition: $\lvert (a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29}-T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert (b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert (G_{31})-(G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and $(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
Definition of $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and\ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}, i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)}+(a_i')^{(5)}+\ (\hat{A}_{28})^{(5)}+\ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)}+(b_i')^{(5)}+\ (\hat{B}_{28})^{(5)}+\ (\hat{Q}_{28})^{(5)}\ \ (\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i')^{(6)},(a_i'')^{(6)},(b_i)^{(6)},(b_i')^{(6)},(b_i'')^{(6)}>0,\quad i,j=32,33,34$ The functions $(a_i'')^{(6)},(b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)},\ \ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t)\leq(p_i)^{(6)}\leq(\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t)\leq\ \ (r_i)^{(6)}\leq(b_i')^{(6)}\leq(\hat{B}_{32})^{(6)}$	127
$lim_{T_2\to\infty}(a_i'')^{(6)}\,(T_{33},t)=(p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}\left((G_{35}),t\right)=\ \ (r_i)^{(6)}$ **Definition of** $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$:	128

Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}((G_{35}), t)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}, \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(KKKKKKKK) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i, j = 36,37,38$ (LLLLLLLL) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(7)}, (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(MMMMMMMM) $\lim_{T_2 \to \infty} (a_i'')^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(NNNNNNNN)* $\lim_{G \to \infty} (b_i'')^{(7)} ((G_{39}), t) = (r_i)^{(7)}$	132

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}',t) - (a_i'')^{(7)}(T_{37},t)\rvert \leq (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})',t) - (b_i'')^{(7)}((G_{39}),t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}',t)$ and $(a_i'')^{(7)}(T_{37},t)$. (T_{37}',t) and (T_{37},t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i'')^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (OOOOOOOO) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (PPPPPPPP) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41},t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138

$(b_i'')^{(8)}((G_{43}),t) \leq \ (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i'')^{(8)}(T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i'')^{(8)}\big((G_{43}),t\big) = \ (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t) - (a_i'')^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}\big((G_{43}),t\big)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\big[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\big]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}} \ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[\,(a_i)^{(8)} + (a_i')^{(8)} + \ (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}\,(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[\ (b_i)^{(8)} + (b_i')^{(8)} + \ (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}\ (\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(9)}, \ (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t) \leq \ (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$	
$\lim_{T_2 \to \infty} (a_i^{''})^{(9)} (T_{45},t) = (p_i)^{(9)}$ $\lim_{G \to \infty} (b_i^{''})^{(9)} (G_{47},t) = \ (r_i)^{(9)}$ **Definition of** $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$: Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$	
They satisfy Lipschitz condition: $\lvert(a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t)\rvert \leq (\hat{k}_{44})^{(9)} \lvert T_{45} - T_{45}^{'}\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}((G_{47}),t)\rvert < (\hat{k}_{44})^{(9)} \lvert\lvert(G_{47}) - (G_{47})^{'}\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and$(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $\left[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\right]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$	
Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities $\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)} + (a_i^{'})^{(9)} + \ (\hat{A}_{44})^{(9)} + \ (\hat{P}_{44})^{(9)} \ (\hat{k}_{44})^{(9)}] < 1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)} + (b_i^{'})^{(9)} + \ (\hat{B}_{44})^{(9)} + \ (\hat{Q}_{44})^{(9)} \ (\hat{k}_{44})^{(9)}] < 1$	

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0)\,, T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13}\right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,, T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,, T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,, T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,, T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,, T_i(0)$:	153

$G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \left(\hat{Q}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
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$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}')^{(1)} + a_{13}'')^{(1)} \left(T_{14}(s_{(13)}), s_{(13)} \right) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}')^{(1)} + (a_{14}'')^{(1)} \left(T_{14}(s_{(13)}), s_{(13)} \right) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}')^{(1)} + (a_{15}'')^{(1)} \left(T_{14}(s_{(13)}), s_{(13)} \right) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
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$0 \le G_i(t) - G_i^0 \le (\,\hat{P}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)}t}$	
$0 \le T_i(t) - T_i^0 \le (\,\hat{Q}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)}t}$	
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$0 \le G_i(t) - G_i^0 \le (\,\hat{P}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)}t}$	
$0 \le T_i(t) - T_i^0 \le (\,\hat{Q}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)}t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a'_{20})^{(3)} + a''_{20})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{20}\left(s_{(20)}\right)\right] ds_{(20)}$	161
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$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
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$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
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$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
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$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
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$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
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$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
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$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{32})^{(6)}, T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a'_{32})^{(6)} + a''_{32})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
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$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
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$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \le (\hat{P}_{36})^{(7)} \,, T_i^0 \le (\hat{Q}_{36})^{(7)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
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$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{38}\left(s_{(36)}\right)\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}\left(G_{39}\left(s_{(36)}\right), s_{(36)}\right)\right) T_{36}\left(s_{(36)}\right)\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}\left(s_{(36)}\right) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}\left(G_{39}\left(s_{(36)}\right), s_{(36)}\right)\right) T_{37}\left(s_{(36)}\right)\right] ds_{(36)}$	
$\bar{\mathrm{T}}_{38}(\mathrm{t}) = \mathrm{T}_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}\left(G_{39}\left(s_{(36)}\right), s_{(36)}\right)\right) T_{38}\left(s_{(36)}\right)\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
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$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \le (\hat{P}_{40})^{(8)} \,, T_i^0 \le (\hat{Q}_{40})^{(8)},$	
$0 \le G_i(t) - G_i^0 \le (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}\left(s_{(40)}\right) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{40}\left(s_{(40)}\right)\right] ds_{(40)}$	166
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$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
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$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)}\left(G_{17}^0 + (\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)}t\right)G_{17}^0 + \frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t} - 1\right)$	169
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In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(\left((G_{39})^{(1)},(T_{39})^{(1)}\right),\left((G_{39})^{(2)},(T_{39})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{36})^{(7)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{39})},\widetilde{(T_{39})}$: $\left(\widetilde{(G_{39})},\widetilde{(T_{39})}\right)=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$ It results $\left\|\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}\right\|\leq\int_0^t(a_{36})^{(7)}\left\|G_{37}^{(1)}-G_{37}^{(2)}\right\|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\,ds_{(36)}+$ $\int_0^t\{(a_{36}')^{(7)}\left\|G_{36}^{(1)}-G_{36}^{(2)}\right\|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{-(\hat{M}_{36})^{(7)}s_{(36)}}+$ $(a_{36}'')^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)\left\|G_{36}^{(1)}-G_{36}^{(2)}\right\|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}+$ $G_{36}^{(2)}\|(a_{36}'')^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)-(a_{36}'')^{(7)}\left(T_{37}^{(2)},s_{(36)}\right)\|\;e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	258
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
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it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)}-(a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for t > 0	
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$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)}, (T_{47})^{(1)}), ((G_{47})^{(2)}, (T_{47})^{(2)})\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+} |G_i^{(1)}(t) - G_i^{(2)}(t)|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+} |T_i^{(1)}(t) - T_i^{(2)}(t)|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})} : (\widetilde{(G_{47})}, \widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}), (T_{47}))$
It results

$$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)} +$$
$$\int_0^t \{(a'_{44})^{(9)}|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)})|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a''_{44})^{(9)}(T_{45}^{(2)}, s_{(44)})|\ e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}|e^{-(\hat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(((G_{47})^{(1)}, (T_{47})^{(1)};\ (G_{47})^{(2)}, (T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ *and* $(\hat{Q}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}$, $i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}\left((G_{47})(t), t\right)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i'')^{(9)}\left((G_{47})(t), t\right) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}\left((G_{47})(t), t\right) = (b_{46}')^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14}, t) + (a_{14}'')^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)}, , (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
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Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}^{'})^{(2)}$ $(R_2)^{(2)} = (b_{18}^{'})^{(2)} - (r_{18})^{(2)}$	318
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$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
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$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
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<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
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$(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_1)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	
Definition of $(\bar{\nu}_1)^{(4)},,(\bar{\nu}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)}>0,(\bar{\nu}_2)^{(4)}<0$ and respectively $(\bar{u}_1)^{(4)}>0,(\bar{u}_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_2)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(\nu_0)^{(4)},(m_1)^{(4)}=(\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)}<(\nu_1)^{(4)}$ $(m_2)^{(4)}=(\nu_1)^{(4)},(m_1)^{(4)}=(\bar{\nu}_1)^{(4)},\boldsymbol{if}\ (\nu_4)^{(4)}<(\nu_0)^{(4)}<(\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(\nu_4)^{(4)},(m_1)^{(4)}=(\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)}<(\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar{u}_1)^{(4)},\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)}=\frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(u_0)^{(4)},\boldsymbol{if}\ (\bar{u}_1)^{(4)}<(u_0)^{(4)}$ where $(u_1)^{(4)},(\bar{u}_1)^{(4)}$	331
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$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t}-e^{-(S_2)^{(4)}t}\right]+G_{26}^0 e^{-(S_2)^{(4)}t}\leq G_{26}(t)\leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}}$	
$\frac{1}{(\mu_1)^{(4)}}T_{24}^0 e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq\frac{1}{(\mu_2)^{(4)}}T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0 e^{-(b_{26}')^{(4)}t}\leq T_{26}(t)\leq$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}^{'})^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}^{'})^{(4)}$ $(R_2)^{(4)}=(b_{26}^{'})^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\le-(a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}-(a_{28}^{''})^{(5)}(T_{29},t)+(a_{29}^{''})^{(5)}(T_{29},t)\le-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\le-(b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31}),t)-(b_{29}^{''})^{(5)}((G_{31}),t)\le-(\tau_1)^{(5)}$	338
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and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},$ ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)},$ ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33},t) + (a''_{33})^{(6)}(T_{33},t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}),t\big) - (b''_{33})^{(6)}\big((G_{35}),t\big) \leq -(\tau_1)^{(6)}$	
<u>**Definition of**</u> $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
<u>**Definition of**</u> $(\bar{\nu}_1)^{(6)}, , (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\big(\nu^{(6)}\big)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\big(u^{(6)}\big)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ <u>**Definition of**</u> $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}$, ***if*** $(\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}$, ***if*** $(\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}$, ***if*** $(\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}$, ***if*** $(u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}$, ***if*** $(u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}$, ***if*** $(\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)}G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\right.\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)} t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)} t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)} t}\right] + G_{38}^0 e^{-(S_2)^{(7)} t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)} t} - e^{-(a_{38}')^{(7)} t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)} t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})}\left[e^{(R_1)^{(7)} t} - e^{-(b_{38}')^{(7)} t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)} t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)} + (r_{36})^{(7)} + (R_2)^{(7)})}\left[e^{((R_1)^{(7)} + (r_{36})^{(7)})t} - e^{-(R_2)^{(7)} t}\right] + T_{38}^0 e^{-(R_2)^{(7)} t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$	370

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$

$(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$

$(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$

Behavior of the solutions of equation 371

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$:

$(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying

$-(\sigma_2)^{(8)} \leq -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$

$-(\tau_2)^{(8)} \leq -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$

Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: 372

By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$
and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and

Definition of $(\bar{\nu}_1)^{(8)}, , (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$:

By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the

roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$

Definition of $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:-

If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by

$(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}, \; \boldsymbol{if} \; (\nu_0)^{(8)} < (\nu_1)^{(8)}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}, \boldsymbol{if} \; (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$,
and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a'_{42})^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a'_{42})^{(8)}t}\right] + G_{42}^0 e^{-(a'_{42})^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>Definition of</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
<u>Behavior of the solutions of equation 37 to 92</u> **<u>Theorem 2:</u>** If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \; \boldsymbol{if} \; (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \; (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \; \boldsymbol{if} \; (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \; (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \; (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

($\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0e^{-(S_2)^{(9)}t}\leq G_{46}(t)\leq$ $\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a'_{46})^{(9)})}[e^{(S_1)^{(9)}t}-e^{-(a'_{46})^{(9)}t}]+G_{46}^0e^{-(a'_{46})^{(9)}t}$)	
$\boxed{T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}}T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq\frac{1}{(\mu_2)^{(9)}}T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b'_{46})^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b'_{46})^{(9)}t}\right]+T_{46}^0e^{-(b'_{46})^{(9)}t}\leq T_{46}(t)\leq$ $\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0e^{-(R_2)^{(9)}t}$	
Definition of $(S_1)^{(9)},(S_2)^{(9)},(R_1)^{(9)},(R_2)^{(9)}$:- Where $(S_1)^{(9)}=(a_{44})^{(9)}(m_2)^{(9)}-(a'_{44})^{(9)}$ $(S_2)^{(9)}=(a_{46})^{(9)}-(p_{46})^{(9)}$ $(R_1)^{(9)}=(b_{44})^{(9)}(\mu_2)^{(9)}-(b'_{44})^{(9)}$ $(R_2)^{(9)}=(b'_{46})^{(9)}-(r_{46})^{(9)}$	

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14}, t)\right) - (a_{14}^{''})^{(1)}(T_{14}, t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)}e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$	388
It follows $-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$	389
From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}$, $\boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390
In the same manner , we get	391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a''_{16})^{(2)} = (a''_{17})^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b''_{16})^{(2)} = (b''_{17})^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397
Proof : From global equations we obtain	398

$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:-	403

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>**Proof**</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t) \right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ <u>**Definition of**</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)} \left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} \right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)} \left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} \right)$ From which one obtains <u>**Definition of**</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G^0_{36}}{G^0_{37}}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain 421

$$\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \le \frac{d\nu^{(8)}}{dt} \le -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:-

For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$

$$\nu^{(8)}(t) \ge \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}} \quad , \quad \boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$$

it follows $(\nu_0)^{(8)} \le \nu^{(8)}(t) \le (\nu_1)^{(8)}$

In the same manner , we get 422

$$\nu^{(8)}(t) \le \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$$

From which we deduce $(\nu_0)^{(8)} \le \nu^{(8)}(t) \le (\bar{\nu}_8)^{(8)}$

If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, 423

$$(\nu_1)^{(8)} \le \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \le \nu^{(8)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \le (\bar{\nu}_1)^{(8)}$$

If $0 < (\nu_1)^{(8)} \le (\bar{\nu}_1)^{(8)} \le \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain 424

$$(\nu_1)^{(8)} \le \nu^{(8)}(t) \le \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \le (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case** .

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}^{''})^{(9)} = (a_{45}^{''})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}^{''})^{(9)} = (b_{45}^{''})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i^{''})^{(1)} and\ (b_i^{''})^{(1)}$ are independent on t , and the conditions with the notations

$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}^{'})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$,

$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}^{'})^{(1)}(r_{14})^{(1)} - (b_{14}^{'})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$

$with\ \ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i'')^{(6)} and\ (b_i'')^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}')^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}')^{(6)}(r_{33})^{(6)} - (b_{33}')^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (gg) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) +$	486

$(a_{16}'')^{(2)}(T_{17})(a_{17}'')^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}')^{(3)}(a_{21}'')^{(3)}(T_{21}) + (a_{21}')^{(3)}(a_{20}'')^{(3)}(T_{21}) + (a_{20}'')^{(3)}(T_{21})(a_{21}'')^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}')^{(4)}(a_{25}'')^{(4)}(T_{25}) + (a_{25}')^{(4)}(a_{24}'')^{(4)}(T_{25}) + (a_{24}'')^{(4)}(T_{25})(a_{25}'')^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}')^{(5)}(a_{29}'')^{(5)}(T_{29}) + (a_{29}')^{(5)}(a_{28}'')^{(5)}(T_{29}) + (a_{28}'')^{(5)}(T_{29})(a_{29}'')^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}')^{(6)}(a_{33}'')^{(6)}(T_{33}) + (a_{33}')^{(6)}(a_{32}'')^{(6)}(T_{33}) + (a_{32}'')^{(6)}(T_{33})(a_{33}'')^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}')^{(7)}(a_{37}'')^{(7)}(T_{37}) + (a_{37}')^{(7)}(a_{36}'')^{(7)}(T_{37}) + (a_{36}'')^{(7)}(T_{37})(a_{37}'')^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}')^{(8)}(a_{41}'')^{(8)}(T_{41}) + (a_{41}')^{(8)}(a_{40}'')^{(8)}(T_{41}) + (a_{40}'')^{(8)}(T_{41})(a_{41}'')^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}')^{(9)}(a_{45}'')^{(9)}(T_{45}) + (a_{45}')^{(9)}(a_{44}'')^{(9)}(T_{45}) + (a_{44}'')^{(9)}(T_{45})(a_{45}'')^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right]+(b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right]+(b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right] + (b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27}) + (b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right] + (b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*}) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31}) + (b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right] + (b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*}) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35}) + (b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right] + (b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*}) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39}) + (b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right] + (b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*}) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^{*} given by $\varphi(G_{27}) = 0$, T_{25}^{*} given by $f(T_{25}^{*}) = 0$ and $G_{24}^{*} = \frac{(a_{24})^{(4)}G_{25}^{*}}{[(a_{24}^{'})^{(4)}+(a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26}^{*} = \frac{(a_{26})^{(4)}G_{25}^{*}}{[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25}^{*})]}$	516
$T_{24}^{*} = \frac{(b_{24})^{(4)}T_{25}^{*}}{[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}((G_{27})^{*})]}$, $T_{26}^{*} = \frac{(b_{26})^{(4)}T_{25}^{*}}{[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}((G_{27})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^{*} given by $\varphi((G_{31})^{*}) = 0$, T_{29}^{*} given by $f(T_{29}^{*}) = 0$ and $G_{28}^{*} = \frac{(a_{28})^{(5)}G_{29}^{*}}{[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*} = \frac{(a_{30})^{(5)}G_{29}^{*}}{[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29}^{*})]}$	518
$T_{28}^{*} = \frac{(b_{28})^{(5)}T_{29}^{*}}{[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*} = \frac{(b_{30})^{(5)}T_{29}^{*}}{[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*}) = 0$, T_{33}^{*} given by $f(T_{33}^{*}) = 0$ and $G_{32}^{*} = \frac{(a_{32})^{(6)}G_{33}^{*}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*} = \frac{(a_{34})^{(6)}G_{33}^{*}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*} = \frac{(b_{32})^{(6)}T_{33}^{*}}{[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}((G_{35})^{*})]}$, $T_{34}^{*} = \frac{(b_{34})^{(6)}T_{33}^{*}}{[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*}) = 0$, T_{37}^{*} given by $f(T_{37}^{*}) = 0$ and $G_{36}^{*} = \frac{(a_{36})^{(7)}G_{37}^{*}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}^{*} = \frac{(a_{38})^{(7)}G_{37}^{*}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$ $T_{36}^{*} = \frac{(b_{36})^{(7)}T_{37}^{*}}{[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}((G_{39})^{*})]}$, $T_{38}^{*} = \frac{(b_{38})^{(7)}T_{37}^{*}}{[(b_{38}^{'})^{(7)}-(b_{38}^{''})^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*}) = 0$, T_{41}^{*} given by $f(T_{41}^{*}) = 0$ and $G_{40}^{*} = \frac{(a_{40})^{(8)}G_{41}^{*}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42}^{*} = \frac{(a_{42})^{(8)}G_{41}^{*}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)}T_{41}^*}{[(b_{40}^{'})^{(8)}-(b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)}T_{41}^*}{[(b_{42}^{'})^{(8)}-(b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)}G_{45}^*}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)}G_{45}^*}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)}T_{45}^*}{[(b_{44}^{'})^{(9)}-(b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)}T_{45}^*}{[(b_{46}^{'})^{(9)}-(b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial(b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)}G_{13}^*\mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)}G_{14}^*\mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)}G_{15}^*\mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)}T_{13}^*\mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)}T_{14}^*\mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)}T_{15}^*\mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}')^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}')^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}')^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}')^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}')^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(3)}$ *and* $(b_i'')^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}'')^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i'')^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}')^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}')^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}')^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}')^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial(b_i^{''})^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial(b_i^{''})^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G^*_{28}\,\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G^*_{29}\,\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G^*_{30}\,\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T^*_{28}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T^*_{29}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T^*_{30}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 6:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(6)}$ *and* $(b''_i)^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	563
<u>Definition of</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{33})^{(6)}}{\partial T_{33}}(T^*_{33}) = (q_{33})^{(6)} \quad , \frac{\partial (b''_i)^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G^*_{32}\,\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G^*_{33}\,\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G^*_{34}\,\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T^*_{32}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T^*_{33}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T^*_{34}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 7:</u>** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ *and* $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. <u>Proof:</u> Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^*\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*} + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$$

$$+((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}) \left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$$

+

$$((\lambda)^{(2)} + (b_{18}')^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a_{18}')^{(2)} + (p_{18})^{(2)})$$

$$\left[\left(\left((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^* + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)\right]$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^*\right)$$

$$+\left(\left((\lambda)^{(2)} + (a_{17}')^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^* + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^*\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^*\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}')^{(2)} + (b_{17}')^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right) (q_{18})^{(2)}\mathrm{G}_{18}$$

$$+((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}) \left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^* + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^*\right)\} = 0$$

+

$$((\lambda)^{(3)} + (b_{22}')^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a_{22}')^{(3)} + (p_{22})^{(3)})$$

$$\left[\left(\left((\lambda)^{(3)} + (a_{20}')^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^* + (a_{21})^{(3)}(q_{20})^{(3)}G_{20}^*\right)\right]$$

$$\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^* + (b_{21})^{(3)}s_{(20),(21)}T_{21}^*\right)$$

$$+\left(\left((\lambda)^{(3)} + (a_{21}')^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^* + (a_{20})^{(3)}(q_{21})^{(1)}G_{21}^*\right)$$

$$\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^* + (b_{21})^{(3)}s_{(20),(20)}T_{20}^*\right)$$

$\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2 + \left((b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\} = 0$ +	
$\left((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\{\left((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$\left((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\{\left((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(\left((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((b'_{28})^{(5)} + (b'_{29})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right) (q_{30})^{(5)} G_{30}$$

$$+\left((\lambda)^{(5)} + (a'_{28})^{(5)} + (p_{28})^{(5)}\right) \left((a_{30})^{(5)}(q_{29})^{(5)} G^*_{29} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)} G^*_{28}\right)$$

$$\left(\left((\lambda)^{(5)} + (b'_{28})^{(5)} - (r_{28})^{(5)}\right) s_{(29),(30)} T^*_{29} + (b_{29})^{(5)} s_{(28),(30)} T^*_{28}\right)\} = 0$$

$$+$$

$$\left((\lambda)^{(6)} + (b'_{34})^{(6)} - (r_{34})^{(6)}\right)\{\left((\lambda)^{(6)} + (a'_{34})^{(6)} + (p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)}\right)(q_{33})^{(6)} G^*_{33} + (a_{33})^{(6)}(q_{32})^{(6)} G^*_{32}\right)\right]$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(33)} T^*_{33} + (b_{33})^{(6)} s_{(32),(33)} T^*_{33}\right)$$

$$+\left(\left((\lambda)^{(6)} + (a'_{33})^{(6)} + (p_{33})^{(6)}\right)(q_{32})^{(6)} G^*_{32} + (a_{32})^{(6)}(q_{33})^{(6)} G^*_{33}\right)$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(32)} T^*_{33} + (b_{33})^{(6)} s_{(32),(32)} T^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((b'_{32})^{(6)} + (b'_{33})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right) (q_{34})^{(6)} G_{34}$$

$$+\left((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)}\right) \left((a_{34})^{(6)}(q_{33})^{(6)} G^*_{33} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)} G^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(34)} T^*_{33} + (b_{33})^{(6)} s_{(32),(34)} T^*_{32}\right)\} = 0$$

$$+$$

$$\left((\lambda)^{(7)} + (b'_{38})^{(7)} - (r_{38})^{(7)}\right)\{\left((\lambda)^{(7)} + (a'_{38})^{(7)} + (p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)} + (a'_{36})^{(7)} + (p_{36})^{(7)}\right)(q_{37})^{(7)} G^*_{37} + (a_{37})^{(7)}(q_{36})^{(7)} G^*_{36}\right)\right]$$

$$\left(\left((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(37)} T^*_{37} + (b_{37})^{(7)} s_{(36),(37)} T^*_{37}\right)$$

$$+\left(\left((\lambda)^{(7)} + (a'_{37})^{(7)} + (p_{37})^{(7)}\right)(q_{36})^{(7)} G^*_{36} + (a_{36})^{(7)}(q_{37})^{(7)} G^*_{37}\right)$$

$$\left(\left((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(36)} T^*_{37} + (b_{37})^{(7)} s_{(36),(36)} T^*_{36}\right)$$

$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}')^{(7)} + (a_{37}')^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$

$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}')^{(7)} + (b_{37}')^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$

$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}')^{(7)} + (a_{37}')^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$

$+\left((\lambda)^{(7)} + (a_{36}')^{(7)} + (p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)} + (b_{36}')^{(7)} - (r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\} = 0$

$+$

$\left((\lambda)^{(8)} + (b_{42}')^{(8)} - (r_{42})^{(8)}\right)\{\left((\lambda)^{(8)} + (a_{42}')^{(8)} + (p_{42})^{(8)}\right)$

$\left[\left(\left((\lambda)^{(8)} + (a_{40}')^{(8)} + (p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(\left((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(\left((\lambda)^{(8)} + (a_{41}')^{(8)} + (p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(\left((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}')^{(8)} + (a_{41}')^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$

$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}')^{(8)} + (b_{41}')^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$

$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}')^{(8)} + (a_{41}')^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+\left((\lambda)^{(8)} + (a_{40}')^{(8)} + (p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)} + (b_{40}')^{(8)} - (r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$

$+$

$\left((\lambda)^{(9)} + (b_{46}')^{(9)} - (r_{46})^{(9)}\right)\{\left((\lambda)^{(9)} + (a_{46}')^{(9)} + (p_{46})^{(9)}\right)$

$\left[\left(\left((\lambda)^{(9)} + (a_{44}')^{(9)} + (p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$\left(\left((\lambda)^{(9)} + (b_{44}')^{(9)} - (r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(\left((\lambda)^{(9)} + (a_{45}')^{(9)} + (p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION THIRTY THREE

Matrix Quantum Mechanics As A Fundamental Theory

INTRODUCTION—VARIABLES USED

String theory. Please see Wikipedia for references. Following exposition has been written in model able form and accentuation attrition models can be applied for each proposition, be it the string theory component concatenation of the much finer subtle elements of M theory.

(1) To understand M-theory one must first have some knowledge of string theory. For hundreds of years, scientists have thought that the simplest objects in the universe are (=) points, like dots.
(2) String theory says that this is (=) wrong and that the simplest objects in the universe are shaped (e&eb) like pieces of string.
(3) These strings are so small that even when looked at very closely (erb) they look like points.
(4) Each basic particle is created by (e) the strings vibrating in different patterns.
(5) The reason scientists had not thought of this idea for so long is that strings are (=) much harder to work with than points.
(6) They seem to break (e) such rules as causality and special relativity, which says that information, cannot travel faster than the speed of light.
(7) String theory has been developed because of (e) a very important problem that has existed for (e) almost 100 years.
(8) Albert Einstein's theory that describes (eb) the universe on very large scales (it is called general

relativity), disagrees (e) with two theories that describe things on very small scales (they are called quantum mechanics and the standard model).

(9) There are also problems with the Standard Model: it includes about 20 numbers that seem to have (e) no explanation; it has too many basic particles - some scientists think it needs to have (e) fewer; and it does not (e) include gravity, which is needed to explain weight.

(10) Many of these problems can be solved by (e) thinking of basic particles as (=) strings.

(11) Now there is only one number with no explanation, which gives (eb) the size of the strings.

(12) String theory includes (e) particles that cause gravity, called gravitons; finding this out delighted the scientists who work on string theory. So, string theory successfully brings General Relativity and Quantum Mechanics together.

(13) But there are some problems with string theory. Normally, we think of the universe as (=) having 4 dimensions, or basic directions. 3 of these basic directions can be thought of as "up/down", "forward/backward" and "left/right". The other direction is time. String theory needs 10 basic directions.

(14) These six other directions can be explained if (e) they are "curled up", so they are much too small to see.

(15) For example, by following the path of a spiral, it is possible to go a great distance along it without (e) moving very far.

(16) The 6 other directions can be thought of as (=) tiny spirals - strings can move along them a great distance but not seem to move.

(17) This can be looked at as a mathematical trick—a trick that has little to do with the real world that can be seen and touched. Such tricks are allowed if they give a theory that can better tell us how things work.

(18) Another problem with string theory is that there are (=) 5 different versions of it.

(19) Each version allows (eb) different kinds of strings and says they work in different ways.

(20) String theory is supposed to be (=) a theory of everything so there should be (=) only one version, not 5. M-theory solves this problem.

M-theory

(21) In 1995 Edward Witten started what has been called the Second Superstring Revolution by introducing M-theory to the world.

(22) This theory combines (e&eb) the 5 different string theories (along with a previously abandoned attempt to unify General Relativity and Quantum Mechanics called 11D-Supergravity) into (eb) one theory.

(23) What Witten actually did was to predict that the fact that all these different theories were connected was a result of (e) there being some underlying theory of which they were all approximations. This theory is somewhat vague in nature and has not yet been pinned down.

(24) Additionally, it was found that the equations that required (e) string theory to exist (eb) in 10 dimensions were (=) actually approximations as well.

(25) The proposed M-theory would need one extra dimension and instead be a theory that takes place (eb) in 11 dimensions.

(26) Witten has himself compared this idea in simple terms to (e) a general who takes up a position on (eb) a hilltop, the extra space-coordinate, to get (eb) a better view of the battlefield's two other dimensions.

(27) The combination is accomplished by (e) knitting together (e&eb) a web of relationships between each of the string theories called dualities (specifically, S-duality, T-duality, and U-duality). See authors concatenation model of these theories.

(28) Each of these dualities provides (eb) a way of converting one of the string theories into (e&eb)

another.

(29) T-duality is probably the most easily explained of (e) the dualities.

(30) It has to do with the size, written as R, of (e) the curled up dimensions of the string theories.

(31) It was discovered that by taking a Type IIA string theory that has (e) a size R and changing the radius to 1/R the result will end up being what is equivalent to (=) a Type IIB theory of size R.

(32) This duality, along with the others, creates (eb) connections between (e&eb) all 5 (or 6, if supergravity is counted) theories.

(33) The fact that these dualities existed had been known before (e) Witten came up with (e&eb) the idea of M-theory.

(34) Additional amusement has come for many in guessing what the M might stand for (possibilities include Matrix, Magic, Muffin, Mystery, Mother and Membrane).

(35) Regardless of what the M might possibly mean, M-theory has become one of the most interesting and active areas of research in theoretical physics today.For a more technical explanation, see w: M-theory (simplified explanation).

M-theory From Wikipedia, the free encyclopedia

(36) M-theory is a theory in physics that unifies (e&eb) all consistent versions of superstring theory.

(37) The existence of such a theory was first conjectured by (e) Edward Witten at (eb) a string theory conference at the University of Southern California in the spring of 1995. Witten's announcement initiated a flurry of research activity known as the second superstring revolution.

(38) Prior to Witten's announcement, string theorists had identified five versions of superstring theory. Although these theories appeared at first to be very different, work by several physicists showed that (eb) the theories were related in (e&eb) intricate and nontrivial ways.

(39) In particular, physicists found that apparently distinct theories could be unified by (e) mathematical transformations called S-duality and T-duality.

(40) Witten's conjecture was based in part on (e) the existence of (e) these dualities and in part on (e) the relationship of (e) the string theories to (e&eb) a field theory called eleven-dimensional supergravity.

(41) Although a complete formulation of M-theory is not known, the theory should describe (eb) two- and five-dimensional objects called branes and should be (=) approximated by (e) eleven-dimensional supergravity at low energies.

(42) Modern attempts to formulate M-theory are typically based on (e) matrix theory or the AdS/CFT correspondence.

(43) According to Witten, M should stand for “magic”, “mystery”, or “membrane” according to taste, and the true meaning of the title should be decided when a more fundamental formulation of the theory is known.[1]

(44) Investigations of the mathematical structure of M-theory have spawned important theoretical results in physics and mathematics. More speculatively, M-theory may provide (eb) a framework for developing a unified theory of all of (e) the fundamental forces of nature.

(45) Attempts to connect M-theory to (e&eb) experiment typically focus on (eb) compactifying its extra dimensions to construct candidate models of (e)our four-dimensional world, although so far none have been verified to give rise to physics as observed at, for instance, the Large Hadron Collider.

Background

Quantum gravity and strings

Main articles: Quantum gravity and String theory

A wavy open segment and closed loop of string.

(46) The fundamental objects of string theory are (=) open and closed strings.
(47) One of the deepest problems in modern physics is (=) the problem of quantum gravity.
(48) The current understanding of gravity is based on (e) Albert Einstein's general theory of relativity, which is formulated within (eb) the framework of classical physics.
(49) However, nongravitational forces are described within (e&eb) the framework of quantum mechanics, a radically different formalism for describing physical phenomena based on (e) probability.[a]
(50) A quantum theory of gravity is needed in order to reconcile general relativity with (e&eb) the principles of quantum mechanics,[b] but difficulties arise when (e) one attempts to apply (e&eb) the usual prescriptions of quantum theory to the force of gravity.[c]
(51) String theory is a theoretical framework that attempts to reconcile gravity and (e&eb) quantum mechanics.
(52) In string theory, the point-like particles of particle physics are replaced by (e&eb) one-dimensional objects called strings.
(53) String theory describes how strings propagate through (e&eb) space and interact with (e&eb) each other.
(54) In a given version of string theory, there is only one kind of string, which may look like a small loop or segment of ordinary string and it can vibrate (e&eb) in different ways.
(55) On distance scales larger than the string scale, a string will look (e) just like an ordinary particle, with its mass, charge, and other properties determined by (e) the vibrational state of the string.
(56) In this way, all of the different elementary particles may be viewed as (=) vibrating strings.
(57) One of the vibrational states of a string gives rise to (eb) the graviton, a quantum mechanical particle that carries gravitational force.[d]
(58) There are several versions of string theory: type I, (e&eb) type IIA, (e&eb) type IIB, and (e&eb) two flavors of Heterotic string theory (SO (32) and (e&eb) E8×E8).
(59) The different theories allow (eb) different types of strings, and the particles that arise at (eb) low energies exhibit (eb) different symmetries.
(60) For example, the type I theory includes (e) both open strings (which are segments with endpoints) and (e&eb) closed strings (which form closed loops), while types IIA and (e&eb) IIB include (e) only closed strings.[2]
(61) Each of these five string theories arises as (=) a special limiting case of M-theory.
(62) This theory, like its string theory predecessors, is (=) an example of a quantum theory of gravity.
(63) It describes (eb) a force just like the familiar gravitational force subject to (e&eb) the rules of quantum mechanics.[3]

Number of dimensions

Main article: Compactification (physics)

A tubular surface and corresponding one-dimensional curve (figure deleted due to spatial constraints)

(64) An example of compactification: At large distances, a two dimensional surface with one circular dimension looks one-dimensional.
(65) In everyday life, there are three familiar dimensions of space: height, width and depth. Einstein's general theory of relativity treats (e&eb) time as a dimension on par with (=) the three spatial dimensions; in general relativity, space and time are not modeled as (=) separate entities but are instead unified to (e&eb) a four-dimensional spacetime.

(66) In this framework, the phenomenon of gravity is viewed as a consequence of (e) the geometry of spacetime.[4]
(67) In spite of the fact that the universe is well described by (e) four-dimensional spacetime, there are several reasons why physicists consider theories in (eb) other dimensions.
(68) In some cases, by modeling (e&eb) spacetime in a different number of dimensions, a theory becomes (=) more mathematically tractable, and one can perform calculations and gain (e) general insights more easily.[e]
(69) There are also situations where theories in two or three spacetime dimensions are useful for (e) describing phenomena in condensed matter physics.[5]
(70) Finally, there exist scenarios in which there could actually be (=)more than four dimensions of spacetime which have nonetheless managed to escape detection.[6]
(71) One notable feature of string theory and M-theory is that these theories require (e) extra dimensions of spacetime for (e) their mathematical consistency.
(72) In string theory, spacetime is ten-dimensional, while (e) in M-theory it (=) is eleven-dimensional.
(73) In order to describe real physical phenomena using these theories, one must therefore imagine scenarios in which (eb) these extra dimensions would not be observed in experiments.[7]
(74) Compactification is one way of modifying (e&eb)the number of dimensions in a physical theory.[f]
(75) In compactification, some of the extra dimensions are assumed to (e) "close up" on themselves to form (eb) circles.[8]
(76) In the limit where these curled up dimensions become very small, (eb) one obtains a theory in which spacetime has (e) effectively a lower number of dimensions.
(77) A standard analogy for this is to consider a multidimensional object such as a garden hose. If the hose is viewed from a sufficient distance, (eb) it appears to have only one dimension, its length.
(78) However, as one approaches the hose, (eb) one discovers that it contains a second dimension, its circumference.
(79) Thus, an ant crawling on the surface of the hose would move in (eb) two dimensions.[g]

A diagram **Dualities** indicating the relationships between M-theory and the five string theories**(deleted due to consgtraints on space)**

Main articles: S-duality and T-duality

(80) A diagram of string theory dualities Yellow arrows indicate (eb) S-duality. Blue arrows indicate (eb) T-duality.
(81) These dualities may be combined to obtain (eb) equivalences of any of the five theories with (e&eb) M-theory.[9]
(82) Theories that arise as different limits of M-theory turn out to be related (e&eb) in highly nontrivial ways.
(83) One of the relationships that can exist between (e&eb) these different physical theories is (=) called S-duality.
(84) This is a relationship which says (eb) that a collection of strongly interacting particles in (eb) one theory can, in some cases, be viewed as (=) a collection of weakly interacting particles in (eb) a completely different theory.
(85) Roughly speaking, a collection of particles is said to be (=) strongly interacting if (e) they combine and decay often and weakly interacting if (e)they do so infrequently
(86) . Type I string theory turns out to be equivalent by (e) S-duality to (e) the SO (32) heterotic string theory.
(87) Similarly, type IIB string theory is related to (e&eb) itself in a nontrivial way by (e) S-duality.[10]
(88) Another relationship between different string theories is (=) T-duality.

(89) Here one considers strings propagating (e&eb) around a circular extra dimension.
(90) T-duality states (eb) that a string propagating around (e&eb) a circle of radius R is equivalent to (=) a string propagating around a circle of (e) radius 1/R in the sense that all observable quantities in (eb) one description are identified with quantities in (eb) the dual description.
(91) For example, a string has (e) momentum as it propagates around a circle, and it can also wind around (e&eb) the circle one or more times.
(92) The number of times the string winds around (e&eb) a circle is called the winding number
(93) If a string has momentum p and winding number n in one description, (eb) it will have momentum n and winding number p in the dual description.
(94) For example, type IIA string theory is equivalent to (=) type IIB string theory via (e&eb) T-duality, and the two versions of heterotic string theory are also related by (e&eb) T-duality.[10]
(95) In general, the term duality refers to a situation where (e) two seemingly different physical systems turn out to be equivalent in (eb) a nontrivial way.
(96) If two theories are related by (e) a duality, it means that one theory can be transformed in (e&eb) some way so that it ends up looking just like the other theory.
(97) The two theories are then said to be (=) dual to one another under the transformation. Put differently, the two theories are (=)mathematically different descriptions of the same phenomena.[11]

Supersymmetry

(98) Another important theoretical idea that plays a (e&eb) role in M-theory is (=) supersymmetry
(99) . This is a mathematical relation that exists in certain physical theories between a class of particles called bosons and (e&eb) a class of particles called fermions.
(100) Roughly speaking, fermions are (=) the constituents of matter, while (e) bosons mediate interactions between (e&eb) particles.
(101) In theories with (e&eb) supersymmetry, each boson has (e) a counterpart which is (=) a fermion, and vice versa.
(102) When supersymmetry is imposed as a local symmetry, (eb) one automatically obtains a quantum mechanical theory that includes (e) gravity. Such a theory is called a supergravity theory.[12]
(103) A theory of strings that incorporates (e) the idea of supersymmetry is called a superstring theory.
(104) There are several different versions of superstring theory which are all subsumed within (e) the M-theory framework.
(105) At low energies, the superstring theories are approximated by (e) supergravity in (eb) ten spacetime dimensions.
(106) Similarly, M-theory is approximated at low energies by (e) supergravity in eleven dimensions.[3]

Branes

(107) In string theory and related theories such as supergravity theories, a brane is (=) a physical object that generalizes (eb) the notion of a point particle to higher dimensions.
(108) For example, a point particle can be viewed as (=) a brane of dimension zero, while (e) a string can be viewed as (=) a brane of dimension one.
(109) It is also possible to consider higher-dimensional branes. In dimension p, these are called p-branes.
(110) Branes are dynamical objects which can propagate through (e&eb) spacetime according to

(e&eb) the rules of quantum mechanics.

(111) They can have (e) mass and other attributes such as charge.

(112) A p-brane sweeps out (e) a (p+1)-dimensional volume in spacetime called its worldvolume.

(113) Physicists often study fields analogous to (e) the electromagnetic field which live on (eb) the worldvolume of a brane. The word brane comes from the word "membrane" which refers to a two-dimensional brane.[13]

(114) In string theory, the fundamental objects that give rise to (eb) elementary particles are (=) the one-dimensional strings.

(115) Although the physical phenomena described by (e) M-theory are still poorly understood, physicists know that the theory describes (eb) two- and five-dimensional branes. Much of the current research in M-theory attempts to better understand the properties of these branes.[h]

History and development

Kaluza–Klein theory

(116) In the early 20th century, physicists and mathematicians including Albert Einstein and Hermann Minkowski pioneered the use of four-dimensional geometry for (e) describing the physical world.[14] These efforts culminated in the formulation of Einstein's general theory of relativity, which relates gravity to (e&eb) the geometry of four-dimensional spacetime.[15]

(117) The success of general relativity led to efforts to apply higher dimensional geometry to (e&eb) explains other forces.

(118) In 1919, work by Theodor Kaluza showed that by passing to five-dimensional spacetime, one can unify gravity and (e&eb) electromagnetism into a single force.[15]

(119) This idea was improved by physicist Oskar Klein, who suggested (eb) that the additional dimension proposed by Kaluza could take the form of a circle with radius around 10−30 cm.[16]

(120) The Kaluza–Klein theory and subsequent attempts by Einstein to develop unified field theory were never completely successful. In part this was because Kaluza–Klein theory predicted (eb) a particle that has never been shown to exist, and in part because (e) it was unable to correctly predict (eb) the ratio of an electron's mass to (e&eb) its charge.

(121) In addition, these theories were being developed just as other physicists were beginning to (e) discover quantum mechanics, which would ultimately prove successful in describing (eb) known forces such as electromagnetism, as well as new nuclear forces that were being discovered throughout the middle part of the century. Thus it would take almost fifty years for the idea of new dimensions to be taken seriously again.[17]

Early work on supergravity

Main article: Supergravity

(122) In the 1980s, Edward Witten contributed to the understanding of supergravity theories. In 1995, he introduced M-theory, sparking the second superstring revolution. New concepts and mathematical tools provided fresh insights into general relativity, giving rise to (eb) a period in the 1960s and 70s now known as the golden age of general relativity.[18] In the mid-1970s, physicists began studying higher-dimensional theories combining general relativity with (e&eb) supersymmetry, the so-called supergravity theories.[19]

(123) General relativity does not (e) place any limits on the possible dimensions of (e) spacetime.

(124) Although the theory is typically formulated in four dimensions, (eb) one can write down

the same equations for the gravitational field in any number of dimensions.

(125) Supergravity is more restrictive because (e) it places an upper limit on (eb) the number of dimensions.[12]

(126) In 1978, work by Werner Nahm showed that the maximum spacetime dimension in (eb) which one can formulate a consistent supersymmetric theory is eleven.[20]

(127) In the same year, Eugene Cremmer, Bernard Julia, and Joel Scherk of the École Normale Supérieure showed that supergravity not only permits up (eb) to eleven dimensions but is in fact most elegant in this maximal number of dimensions.[21][22]

(128) Initially, many physicists hoped that by compactifying eleven-dimensional supergravity, it might be possible to construct (eb) realistic models of (e) our four-dimensional world.

(129) The hope was that such models would provide (eb)a unified description of the four fundamental forces of nature: electromagnetism, the strong and weak nuclear forces, and gravity.

(130) Interest in eleven-dimensional supergravity soon waned as various flaws in this scheme were discovered. One of the problems was that the laws of physics appear to distinguish between clockwise and counterclockwise, a phenomenon known as chirality. Edward Witten and others observed this chirality property cannot be readily derived by (e) compactifying from eleven dimensions.[22]

(131) In the first superstring revolution in 1984, many physicists turned to string theory as a unified theory of particle physics and (e&eb) quantum gravity.

(132) Unlike supergravity theory, string theory was able to accommodate *e) the chirality of the standard model, and it provided (eb) a theory of gravity consistent with (e&eb) quantum effects.[22]

(133) Another feature of string theory that many physicists were drawn to in the 1980s and 1990s was (=) its high degree of uniqueness.

(134) In ordinary particle theories, one can consider any collection of (e) elementary particles whose classical behavior is described by (e) an arbitrary Lagrangian. In string theory, the possibilities are much more constrained: by the 1990s, physicists had argued that there were only five consistent supersymmetric versions of the theory.[22]

Relationships between string theories

(135) Although there were only a handful of consistent superstring theories, it remained a mystery why there was not just one consistent formulation.[22] However, as physicists began to examine string theory more closely, they realized that these theories are related in (e&eb)intricate and nontrivial ways.[23]

(136) In the late 1970s, Claus Montonen and David Olive had conjectured a special property of (e) certain physical theories.[24]

(137) A sharpened version of their conjecture concerns (e&eb) a theory called N=4 supersymmetric Yang–Mills theory, which describes (eb) particles similar to the quarks and gluons that make up (e) atomic nuclei.

(138) The strength with which the particles of this theory interact is (=) measured by (e) a number called the coupling constant.

(139) The result of Montonen and Olive, now known as (=) Montonen–Olive duality, states that (eb) N=4 supersymmetric Yang–Mills theory with coupling constant g is equivalent to (=) the same theory with coupling constant 1/g. In other words, a system of strongly interacting (e&eb) particles (large coupling constant) has an equivalent description as (=) a system of weakly interacting (e&eb) particles (small coupling constant) and vice versa.[25]

(140) In the 1990s, several theorists generalized Montonen–Olive duality to (e &êb) the S-duality relationship, which connects (e&eb) different string theories.

(141) Ashoke Sen studied S-duality in the context of (e&*eb) heterotic strings in four dimensions.[26][27]

(142) Chris Hull and Paul Townsend showed that (eb) type IIB string theory with a large coupling constant is equivalent via (e&eb) S-duality to the same theory with (e&eb) small coupling constant.[28]

(143) Theorists also found that different string theories may be related by (e) T-duality.

(144) This duality implies (eb) that strings propagating on (e&eb)completely different spacetime geometries may be physically equivalent.[29]

Membranes and fivebranes

(145) String theory extends ordinary particle physics by promoting (eb) zero-dimensional point particles to (e&eb) one-dimensional objects called strings.

(146) In the late 1980s, it was natural for theorists to attempt to formulate other extensions in which particles are replaced by (e&eb) two-dimensional supermembranes or by (e&eb) higher-dimensional objects called branes.

(147) Such objects had been considered as early as 1962 by Paul Dirac,[30] and they were reconsidered by a small but enthusiastic group of physicists in the 1980s.[22]

(148) Supersymmetry severely restricts (e) the possible number of dimensions of a brane.

(149) In 1987, Eric Bergshoeff, Ergin Sezgin, and Paul Townsend showed (eb) that eleven-dimensional supergravity includes (e) two-dimensional branes.[31]

(150) Intuitively, these objects look like sheets or membranes propagating through (e&eb) the eleven-dimensional spacetime.

(151) Shortly after this discovery, Michael Duff, Paul Howe, Takeo Inami, and Kellogg Stelle considered a particular compactification of eleven-dimensional supergravity with one of the dimensions curled up into a circle.[32]

(152) In this setting, one can imagine the membrane wrapping around the circular dimension. If the radius of the circle is sufficiently small, then (eb) this membrane looks just like a string in ten-dimensional spacetime. I

(153) n fact, Duff and his collaborators showed that this construction reproduces (eb)exactly the strings appearing in type IIA superstring theory.[25]

(154) In 1990, Andrew Strominger published a similar result which suggested that strongly interacting strings in ten dimensions might have (e) an equivalent description in terms of (e&eb)_ weakly interacting five-dimensional branes.[33]

(155) Initially, physicists were unable to prove this relationship for two important reasons. On the one hand, the Montonen–Olive duality was (=) still unproven, and so Strominger's conjecture was (=) even more tenuous.

(156) On the other hand, there were many technical issues related to (e&eb) the quantum properties of five-dimensional branes.[34]

(157) The first of these problems was solved in 1993 when Ashoke Sen established that certain physical theories require (e) the existence of objects with (e&eb) both electric and magnetic charge which were predicted by (e) the work of Montonen and Olive.[35]

(158) In spite of this progress, the relationship between strings and (e&eb) five-dimensional branes remained conjectural because (e) theorists were unable to quantize (eb) the branes

(159) Starting in 1991, a team of researchers including Michael Duff, Ramzi Khuri, Jianxin Lu, and Ruben Minasian considered a special compactification of string theory in which four of (e) the ten dimensions curl up.

(160) If one considers a five-dimensional brane wrapped around (e&eb) these extra dimensions, then (eb) the brane looks just like a one-dimensional string.

(161) In this way, the conjectured relationship between strings and (e&eb) branes was reduced to a relationship between strings and (e&eb)strings, and the latter could be tested using already established theoretical techniques.[29]

Second superstring revolution

A star-shaped diagram with the various limits of M-theory labeled at its six vertices.

(162) A schematic illustration of the relationship between M-theory, (e&eb) the five superstring theories, and (e&eb) eleven-dimensional supergravity.
(163) The shaded region represents (eb) a family of different physical scenarios that are (=) possible in M-theory.
(164) In certain limiting cases corresponding to (e&eb) the cusps, it is natural to describe the physics using (e&eb) one of the six theories labeled there.

Main article: Second superstring revolution

(165) Speaking at the string theory conference at the University of Southern California in 1995, Edward Witten of the Institute for Advanced Study made the surprising suggestion that all five superstring theories were in fact just different limiting cases of (e) a single theory in eleven spacetime dimensions.
(166) Witten's announcement drew together all of the previous results on (e) S- and T-duality and the appearance of two- and five-dimensional branes in (eb) string theory.[36]
(167) In the months following Witten's announcement, hundreds of new papers appeared on the Internet confirming that the new theory involved membranes in an important way.[37] Today this flurry of work is known as the second superstring revolution.[38]
(168) One of the important developments following Witten's announcement was Witten's work in 1996 with string theorist Petr Hořava.[39][40] Witten and Hořava studied M-theory on a special spacetime geometry with (e&eb) two ten-dimensional boundary components. Their work shed light on the mathematical structure of M-theory and suggested possible ways of connecting M-theory to (e&eb) real world physics.[41]

Origin of the term

(169) Initially, some physicists suggested (eb) that the new theory was a fundamental theory of membranes, but Witten was skeptical of the role of (e&eb) membranes in the theory. In a paper from 1996, Hořava and Witten wrote: As it has been proposed that the eleven-dimensional theory is (=) a supermembrane theory but there are (-)some reasons to doubt that interpretation, we will non-committally call it the M-theory, leaving to the future the relation of M to (e&eb) membranes.[39]
(170) In the absence of an understanding of the true meaning and structure of M-theory, Witten has suggested that the M should stand for "magic", "mystery", or "membrane" according to taste, and the true meaning of the title should be decided when a more fundamental formulation of the theory is known.[1]

Matrix theory

BFSS matrix model

Main article: Matrix theory (physics)

(171) In mathematics, a matrix is (=) a rectangular array of numbers or other data. In physics, a matrix model is (=) a particular kind of physical theory whose mathematical formulation involves (e&eb) the notion of a matrix in an important way. A matrix model describes the behavior of a set of matrices within the framework of quantum mechanics.[42][43]

(172) One important example of a matrix model is (=) the BFSS matrix model proposed by (e) Tom Banks, Willy Fischler, Stephen Shenker, and Leonard Susskind in 1997.

(173) This theory describes (eb) the behavior of a set of nine large matrices.

(174) In their original paper, these authors showed, among other things, that the low energy limit of this matrix model is described by (e) eleven-dimensional supergravity.

(175) These calculations led them to (eb) propose that the BFSS matrix model is exactly equivalent to (=) M-theory.

(176) The BFSS matrix model can therefore be used as (=) a prototype for a correct formulation of M-theory and a tool for investigating the properties of M-theory in a relatively simple setting.[42]

Main articles: Noncommutative geometry and Noncommutative quantum field theory

(177) In geometry, it is often useful to (e) introduce coordinates.

(178) For example, in order to study the geometry of the Euclidean plane, one defines (eb) the coordinates x and y as the distances between (e&eb) any point in the plane and a pair of axes.

(179) In ordinary geometry, the coordinates of (e) a point are numbers, so they can be multiplied, and the product of (e) two coordinates does not (e) depend on the order of multiplication.

(180) That is, xy = yx. This property of multiplication is known as (=) the commutative law, and this relationship between geometry and (e&eb) the commutative algebra of coordinates is (=) the starting point for much of modern geometry.[44]

(181) Noncommutative geometry is a branch of mathematics that attempts to generalize (eb) this situation.

(182) Rather than working with ordinary numbers, one considers some similar objects, such as matrices, whose multiplication does not (e) satisfy the commutative law (that is, objects for which xy is not necessarily equal to yx).

(183) One imagines that these noncommuting objects are (=) coordinates on (eb) some more general notion of "space" and proves (eb) theorems about these generalized spaces by (e) exploiting the analogy with ordinary geometry.[45]

(184) In a paper from 1998, Alain Connes, Michael R. Douglas, and Albert Schwarz showed that some aspects of matrix models and M-theory are described by (e) a noncommutative quantum field theory, a special kind of physical theory in which the coordinates on spacetime do not (e) satisfy the commutativity property.[43]

(185) This established a link between matrix models and (e&eb) M-theory on the one hand, and noncommutative geometry on the other hand.

(186) It quickly led to (eb) the discovery of other important links between noncommutative geometry and (e&eb) various physical theories.[46][47]

AdS/CFT correspondence

Overview

Main article: AdS/CFT correspondence

A disk tiled by triangles and quadrilaterals which become smaller and smaller near the boundary

circle.

A tessellation of the hyperbolic plane by triangles and squares.

(187) The application of quantum mechanics to physical objects such as the electromagnetic field, which are extended (e&eb) in space and time, is known as quantum field theory.[i]

(188) In particle physics, quantum field theories form the basis for (e) our understanding of elementary particles, which are (=) modeled as excitations in (eb) the fundamental fields.

(189) Quantum field theories are also used throughout (e&eb) condensed matter physics to model particle-like objects called quasiparticles.[j]

(190) One approach to formulating M-theory and studying its properties is provided by (e) the anti-de Sitter/conformal field theory (AdS/CFT) correspondence

(191) Proposed by Juan Maldacena in late 1997, the AdS/CFT correspondence is (=) a theoretical result which implies (eb)that M-theory is in some cases equivalent to (=) a quantum field theory.[48]

(192) In addition to providing insights into the mathematical structure of string and M-theory, the AdS/CFT correspondence has shed light (eb)on many aspects of quantum field theory in regimes where (e) traditional calculational techniques are ineffective.[49]

(193) In the AdS/CFT correspondence, the geometry of spacetime is described in terms of (e&eb) a certain vacuum solution of Einstein's equation called anti-de Sitter space.[50]

(194) In very elementary terms, anti-de Sitter space is (=) a mathematical model of spacetime in which the notion of distance between points (the metric) is (=) different from (e) the notion of distance in ordinary Euclidean geometry.

(195) It is closely related to (e&eb) hyperbolic space, which can be viewed as (=) a disk as illustrated on the left. [51] (deleted due to spatial restrictions)

(196) This image shows a tessellation of a disk by triangles and squares. One can define the distance between points of this disk in such a way that all the triangles and squares are the same size and the circular outer boundary is infinitely far from any point in the interior.[52]

(197) A cylinder formed by stacking copies of the disk illustrated in the previous figure. (deleted)

(198) Three-dimensional anti-de Sitter space is like a stack of hyperbolic disks, each one representing the state of the universe at a given time. One can study theories of quantum gravity such as M-theory in the resulting spacetime.

(199) Now imagine a stack of hyperbolic disks where each disk represents the state of the universe at a given time. The resulting geometric object is three-dimensional anti-de Sitter space.[51] It looks like a solid cylinder in which any cross section is a copy of the hyperbolic disk. Time runs along the vertical direction in this picture. The surface of this cylinder plays an important role in the AdS/CFT correspondence. As with the hyperbolic plane, anti-de Sitter space is curved in such a way that any point in the interior is actually infinitely far from this boundary surface.[52]

(200) This construction describes a hypothetical universe with only two space dimensions and one time dimension, but it can be generalized to any number of dimensions. Indeed, hyperbolic space can have more than two dimensions and one can "stack up" copies of hyperbolic space to get higher-dimensional models of anti-de Sitter space.[51]

(201) An important feature of anti-de Sitter space is (==) its boundary (which looks like a cylinder in the case of three-dimensional anti-de Sitter space).

(202) One property of this boundary is that, within a small region on the surface around any given point, it looks just like Minkowski space, the model of spacetime used in nongravitational physics.[53] One can therefore consider an auxiliary theory in which "spacetime" is given by the boundary of anti-de Sitter space. This observation is the starting point for AdS/CFT

correspondence, which states that the boundary of anti-de Sitter space can be regarded as the "spacetime" for a quantum field theory. The claim is that this quantum field theory is equivalent to the gravitational theory on the bulk anti-de Sitter space in the sense that there is a "dictionary" for translating entities and calculations in one theory into their counterparts in the other theory. For example, a single particle in the gravitational theory might correspond to some collection of particles in the boundary theory. In addition, the predictions in the two theories are quantitatively identical so that if two particles have a 40 percent chance of colliding in the gravitational theory, then the corresponding collections in the boundary theory would also have a 40 percent chance of colliding.[54]

6D (2,0) superconformal field theory

Main article: 6D (2,0) superconformal field theory

A collection of knot diagrams in the plane.

(203) The six-dimensional (2,0)-theory has been used to understand results from the mathematical theory of knots

(204) One particular realization of the AdS/CFT correspondence states that M-theory on the product space AdS7×S4 is equivalent to the so-called (2,0)-theory on the six-dimensional boundary.[48] Here "(2,0)" refers to the particular type of supersymmetry that appears in the theory. In this example, the spacetime of the gravitational theory is effectively seven-dimensional (hence the notation AdS7), and there are four additional "compact" dimensions (encoded by the S4 factor). In the real world, spacetime is four-dimensional, at least macroscopically, so this version of the correspondence does not provide a realistic model of gravity. Likewise, the dual theory is not a viable model of any real-world system since it describes a world with six spacetime dimensions.[k]

(205) Nevertheless, the (2, 0)-theory has proven to be (=) important for studying the general properties of quantum field theories. Indeed, this theory subsumes many mathematically interesting effective quantum field theories and points to new dualities relating these theories. For example, Luis Alday, Davide Gaiotto, and Yuji Tachikawa showed that by compactifying this theory on a surface, one obtains a four-dimensional quantum field theory, and there is a duality known as the AGT correspondence which relates the physics of this theory to certain physical concepts associated with the surface itself.[55] More recently, theorists have extended these ideas to study the theories obtained by compactifying down to three dimensions.[56]

(206) In addition to its applications in quantum field theory, the (2,0)-theory has (eb) spawned important results in pure mathematics

(207) . For example, the existence of the (2,0)-theory was used by Witten to give a "physical" explanation for a conjectural relationship in mathematics called the geometric Langlands correspondence.[57] In subsequent work, Witten showed that the (2,0)-theory could be used to understand (e) a concept in mathematics called Khovanov homology.[58] Developed by Mikhail Khovanov around 2000, Khovanov homology provides a tool in knot theory, the branch of mathematics that studies and classifies the different shapes of knots.[59] Another application of the (2,0)-theory in mathematics is the work of Davide Gaiotto, Greg Moore, and Andrew Neitzke, which used physical ideas to derive new results in hyperkähler geometry.[60]

ABJM superconformal field theory

Main article: ABJM superconformal field theory

(208) Another realization of the AdS/CFT correspondence states that M-theory on AdS4×S7 is

equivalent to a quantum field theory called the ABJM theory in three dimensions. In this version of the correspondence, seven of the dimensions of M-theory are curled up, leaving four non-compact dimensions. Since the spacetime of our universe is four-dimensional, this version of the correspondence provides a somewhat more realistic description of gravity.[61]

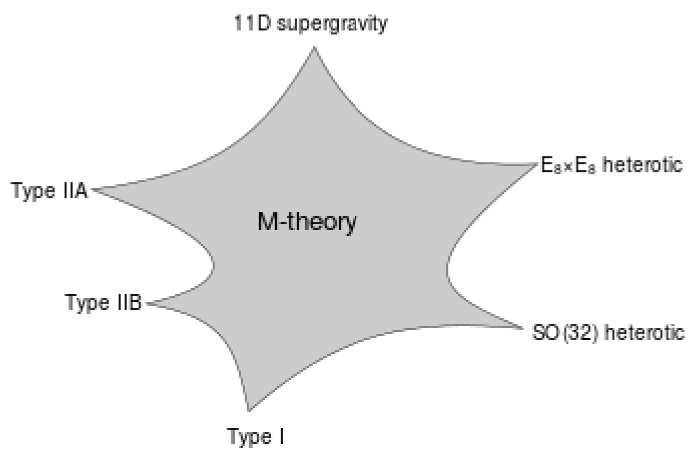
(209) The ABJM theory appearing in this version of the correspondence is also interesting for a variety of reasons. Introduced by Aharony, Bergman, Jafferis, and Maldacena, it is closely related to another quantum field theory called Chern–Simons theory. The latter theory was popularized by Witten in the late 1980s because of its applications to knot theory.[62] In addition, the ABJM theory serves as a semi-realistic simplified model for solving problems that arise in condensed matter physics.[61]

Phenomenology

Overview

Main article: String phenomenology

Visualization of a complex mathematical surface with many convolutions and self intersections.



A cross section of a Calabi–Yau manifold

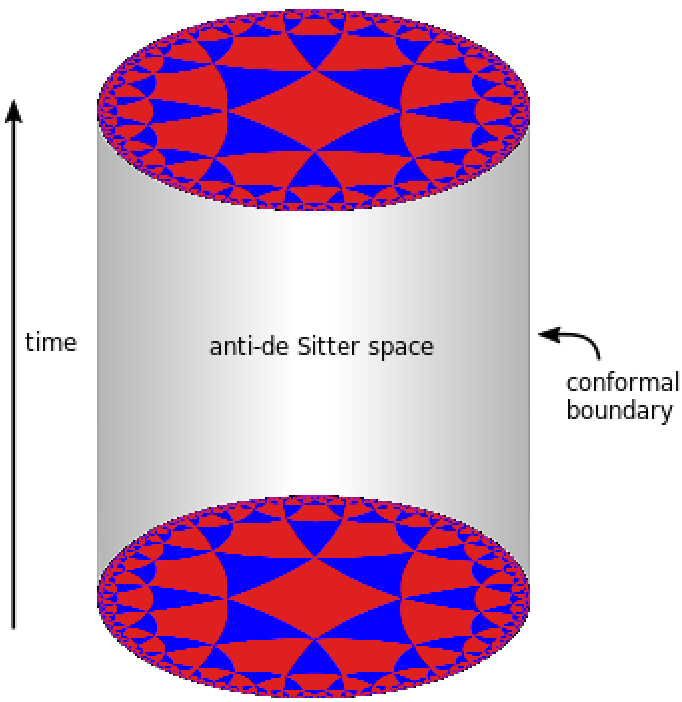
(210) In addition to being an idea of considerable theoretical interest, M-theory provides a framework for constructing models of real world physics that combine general relativity with the standard model of particle physics. Phenomenology is the branch of theoretical physics in which physicists construct realistic models of nature from more abstract theoretical ideas. String phenomenology is the part of string theory that attempts to construct realistic models of particle physics based on string and M-theory.[63]

(211) Typically, such models are based on the idea of compactification.[l] Starting with the ten- or eleven-dimensional spacetime of string or M-theory, physicists postulate a shape for the extra dimensions. By choosing this shape appropriately, they can construct models roughly similar to the standard model of particle physics, together with additional undiscovered particles,[64] usually supersymmetric partners to analogues of known particles. One popular way of deriving realistic physics from string theory is to start with the heterotic theories in ten dimensions and assume that the six extra dimensions of spacetime are shaped like a six-dimensional Calabi–Yau manifold. This is a special kind of geometric object named after mathematicians Eugenio Calabi and Shing-Tung Yau.[65] Calabi–Yau manifolds offer many ways of extracting realistic physics from string theory.

Other similar methods can be used to construct models with physics resembling to some extent that of our four-dimensional world based on M-theory.[66]

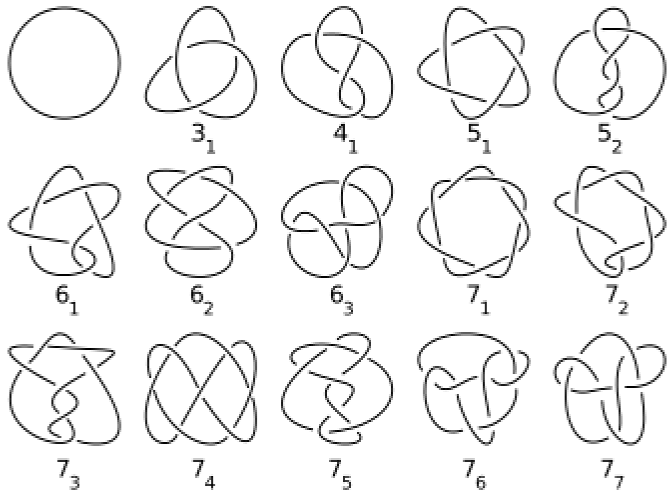
(212) Partly because of theoretical and mathematical difficulties and partly because of the extremely high energies (beyond what is technologically possible for the foreseeable future) needed to test these theories experimentally, there is so far no experimental evidence that would unambiguously point to any of these models being a correct fundamental description of nature. This has led some in the community to criticize these approaches to unification and question the value of continued research on these problems.[67]

Compactification on G2 manifolds



(213) In one approach to M-theory phenomenology, theorists assume that the seven extra dimensions of M-theory are shaped like a G2 manifold. This is a special kind of seven-dimensional shape constructed by mathematician Dominic Joyce of the University of Oxford.[68] These G2 manifolds are still poorly understood mathematically, and this fact has made it difficult for physicists to fully develop this approach to phenomenology.[69]

(214) For example, physicists and mathematicians often assume that space has a mathematical property called smoothness, but this property cannot be assumed in the case of a G2 manifold if one wishes to recover the physics of our four-dimensional world. Another problem is that G2 manifolds are not complex manifolds, so theorists are unable to use tools from the branch of mathematics known as complex analysis. Finally, there are many open questions about the existence, uniqueness, and other mathematical properties of G2 manifolds, and mathematicians lack a systematic way of searching for these manifolds.[69]



(215)

Heterotic M-theory

(216) Because of the difficulties with G2 manifolds, most attempts to construct realistic theories of physics based on M-theory have taken a more indirect approach to compactifying eleven-dimensional spacetime. One approach, pioneered by Witten, Hořava, Burt Ovrut, and others, is known as heterotic M-theory. In this approach, one imagines that one of the eleven dimensions of M-theory is shaped like a circle. If this circle is very small, then the spacetime becomes effectively ten-dimensional. One then assumes that six of the ten dimensions form a Calabi–Yau manifold. If this Calabi–Yau manifold is also taken to be small, one is left with a theory in four-dimensions.[69]

(217) Heterotic M-theory has been used to construct models of brane cosmology in which the observable universe is thought to exist on a brane in a higher dimensional ambient space. It has also spawned alternative theories of the early universe that do not rely on the theory of cosmic inflation.[69]The Official String Theory Web Site:--> Basics -->How many theories? (basic / advanced)

Is there a more fundamental theory?

More than just strings

(218) Another surprising revelation was that superstring theories are not just theories of one-dimensional objects. There are higher dimensional objects in string theory with dimensions from zero (points) to nine, called p-branes. In terms of branes, what we usually call a membrane would be a two-brane, a string is called a one-brane and a point is called a zero-brane.

(219) What makes a p-brane? A p-brane is a spacetime object that is a solution to the Einstein equation in the low energy limit of superstring theory, with the energy density of the nongravitational fields confined to some p-dimensional subspace of the nine space dimensions in the theory. (Remember, superstring theory lives in ten spacetime dimensions, which means one time dimension plus nine space dimensions.) For example, in a solution with electric charge, if the energy density in the electromagnetic field was distributed along a line in spacetime, this one-dimensional line would be considered a p-brane with p=1.

(220) Special classes of p-branes in string theory are called D branes. Roughly speaking, a D brane is a p-brane where the ends of open strings are localized on the brane. A D brane is like a collective excitation of strings.

(221) These objects took a long time to be discovered in string theory, because (e) they are buried (eb) deep in the mathematics of T-duality.

(222) D branes are important in understanding black holes in string theory, especially in counting the quantum states that lead to black hole entropy, which was a very big accomplishment for string theory.

How many dimensions?

(223) Before string theory won the full attention of the theoretical physics community, the most popular unified theory was an eleven dimensional theory of supergravity, which is supersymmetry combined with (e&eb) gravity.

(224) The eleven-dimensional spacetime was to be compactified on (e&eb) a small 7-dimensional sphere, for example, leaving (e) four spacetime dimensions visible to observers' at large distances.

(225) This theory didn't work as a unified theory of particle physics, because it doesn't have a sensible quantum limit as a point particle theory. But this eleven dimensional theory would not die. It eventually came back to life in the strong coupling limit of superstring theory in ten dimensions.

(226) How could a superstring theory with ten spacetime dimensions turn into a supergravity theory with eleven spacetime dimensions? We've already learned that duality relations between superstring theories relate very different theories, equate large distance with small distance, and exchange strong coupling with weak coupling. So there must be some duality relation that can explain how a superstring theory that requires ten spacetime dimensions for quantum consistency can really be a theory in eleven spacetime dimensions after all.

(227) Since we know that all string theories are related, and we suspect that they are but different limits of some more fundamental theory, then perhaps that more fundamental theory exists in eleven spacetime dimensions? These questions bring us to the topic of M theory.

The theory currently known as M

(228) Technically speaking, M theory is is the unknown eleven-dimensional theory whose low energy limit is the supergravity theory in eleven dimensions discussed above. However, many people have taken to also using M theory to label the unknown theory believed to be the fundamental theory from which the known superstring theories emerge as special limits.

(229) We still don't know the fundamental M theory, but a lot has been learned about the eleven-dimensional M theory and how it relates to superstrings in ten spacetime dimensions.

(230) In M theory, there are also extended objects, but they are called M branes rather than D branes. One class of the M branes in this theory has two space dimensions, and this is called an M2 brane.

(231) Now consider M theory with the tenth space dimension compactified into a circle of radius R. If one of the two space dimensions that make up the M2 brane is wound around that circle, then we can equate the resulting object with the fundamental string (one-brane) of type IIA superstring theory. The type IIA theory appears to be a ten dimensional theory in the normal perturbative limit, but reveals an extra space dimension, and equivalence to M theory, in the limit of very strong coupling.

(232) We still don't know what the fundamental theory behind string theory is, but judging from all of these relationships, it must be a very interesting and rich theory

(233) one where distance scales, coupling strengths and even the number of dimensions in spacetime are not fixed concepts but fluid entities that shift with our point of view.

Matrix theory: matrix quantum mechanics as a fundamental theory Washington Taylor Rev. Mod. Phys. 73, 419 – Published 8 June 2001

(1) This article reviews the matrix model of M theory. M theory is (=) an 11-dimensional quantum theory of gravity that is believed to underlie (e&eb) all superstring theories.
(2) M theory is currently the most plausible candidate for (e) a theory of fundamental physics which reconciles gravity and (e&eb) quantum field theory in a realistic fashion.
(3) Evidence for M theory is still only circumstantial—no complete background-independent formulation of the theory exists as yet. Matrix theory was first developed as a regularized theory of (e) a supersymmetric quantum membrane.
(4) More recently, it has appeared in a different guise as the discrete light-cone quantization of (e) M theory in flat space.
(5) These two approaches to matrix theory are described in detail and compared. It is shown that matrix theory is a well-defined quantum theory that reduces to (e&eb) a supersymmetric theory of gravity at low energies.
(6) Although its fundamental degrees of freedom are (=) essentially pointlike, higher-dimensional fluctuating objects (branes) arise through (e&eb) the non-Abelian structure of the matrix degrees of (e) freedom.
(7) The problem of formulating matrix theory in (eb) a general space-time background is discussed, and the connections between matrix theory and (e&eb) other related models are reviewed. DOI: http://dx.doi.org/10.1103/RevModPhys.73.419

Two-component spinor techniques and Feynman rules for quantum field theory and supersymmetry Herbi K. Dreiner, Howard E. Haber, Stephen P. Martin

(8) Two-component spinors are the basic ingredients for describing fermions in (eb) quantum field theory in (eb) four space-time dimensions.
(9) Authors develop and review the techniques of (e) the two-component spinor formalism and provide (eb) a complete set of Feynman rules for (e) fermions using (e) two-component spinor notation.
(10) These rules are suitable for (e) practical calculations of cross-sections, decay rates, and radiative corrections in the Standard Model and its extensions, including supersymmetry, and many explicit examples are provided.
(11) The unified treatment presented in this review applies to (e&eb) massless Weyl fermions and massive Dirac and Majorana fermions.
(12) Authors exhibit the relation between the two-component spinor formalism and (e&eb) the more traditional four-component spinor formalism, and indicate their connections to (e&eb) the spinor helicity method and techniques for the computation of helicity amplitudes. Subjects: High Energy Physics - Phenomenology (hep-ph); High Energy Physics - Theory (hep-th) Journal reference: Phys.Rept.494:1-196,2010 DOI: 10.1016/j.physrep.2010.05.002 Report number: BN-TH-2008-12 and SCIPP-08/08 Cite as: arXiv:0812.1594 [hep-ph] (or arXiv:0812.1594v5 [hep-ph] for this version)

NOTATION

Module One

This article reviews the matrix model of M theory. M theory is (=) an 11-dimensional quantum theory of gravity that is believed to underlie (e&eb) all superstring theories

G_{13} : Category one of M theory

G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of11-dimensional quantum theory of gravity that is believed to underlie (e&eb) all superstring theories T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two This article reviews the matrix model of M theory. M theory is an 11-dimensional quantum theory of gravity that is believed to underlie (e&eb) all superstring theories	
G_{16} : Category one of **M theory is an 11-dimensional quantum theory of gravity;** all superstring theories G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of all superstring theories; **M theory is an 11-dimensional quantum theory of gravity** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three Evidence for M theory is still only circumstantial—no complete background-independent formulation of the theory exists as yet. Matrix theory was first developed as a regularized theory of (e) a supersymmetric quantum membrane	
G_{20} : Category one of **regularized theory;** supersymmetric quantum membrane G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of supersymmetric quantum membrane **;regularized theory** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four These two approaches to matrix theory are described in detail and compared. It is shown that matrix theory is a well-defined quantum theory that reduces to (e&eb) a supersymmetric theory of gravity at low energies	
G_{24} : Category one of **matrix theory is a well-defined quantum theory;** supersymmetric theory of gravity	

at low energies G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of supersymmetric theory of gravity at low energies **;matrix theory is a well-defined quantum theory** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Although its fundamental degrees of freedom are (=) essentially pointlike, higher-dimensional fluctuating objects (branes) arise through (e&eb) the non-Abelian structure of the matrix degrees of (e) freedom.	
G_{28} : Category one of fundamental degrees of freedom G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of pointlike T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six Although its fundamental degrees of freedom are essentially pointlike, higher-dimensional fluctuating objects (branes) arise through (e&eb) the non-Abelian structure of the matrix degrees of freedom	
G_{32} : Category one of **higher-dimensional fluctuating objects (branes) arise;** non-Abelian structure of the matrix degrees of freedom G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of non-Abelian structure of the matrix degrees of freedom **;higher-dimensional fluctuating objects (branes) arise** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven Two-component spinors are the basic ingredients for describing fermions in (eb) quantum field theory in (eb) four space-time dimensions	

G_{36} : Category one of **Two-component spinors are the basic ingredients for describing fermions;** quantum field theory in four space-time dimensions G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of quantum field theory in four space-time dimensions **; Two-component spinors are the basic ingredients for describing fermions** T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight Authors develop and review the techniques of (e) the two-component spinor formalism and provide (eb) a complete set of Feynman rules for fermions using (e) two-component spinor notation	
G_{40} : Category one of f two-component spinor notation G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of complete set of Feynman rules for fermions T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine The unified treatment presented in this review applies to (e&eb) massless Weyl fermions and massive Dirac and Majorana fermions	
G_{44} : Category one of **unified treatment presented;** massless Weyl fermions and massive Dirac and Majorana fermions G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of massless Weyl fermions and massive Dirac and Majorana fermions **;unified treatment presented** T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	

$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t)\right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t)\right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t)\right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t)\right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t)\right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}, t)\right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}, t)\right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}), t\right)\right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}), t\right)\right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}), t\right)\right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}), t\right) =$ First detritions factor	
Module Numbered Three	

The differential system of this model is now (Module numbered three)	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33},t)\right]G_{33}$	32

$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	*42*
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	

$$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14},t) + (a''_{16})^{(2,2,)}(T_{17},t) + (a''_{20})^{(3,3,)}(T_{21},t) \\ + (a''_{24})^{(4,4,4,4,)}(T_{25},t) + (a''_{28})^{(5,5,5,5,)}(T_{29},t) + (a''_{32})^{(6,6,6,6,)}(T_{33},t) \\ + (a''_{36})^{(7,7)}(T_{37},t) + (a''_{40})^{(8,8)}(T_{41},t) + (a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{13} \quad 55$$

$$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \begin{bmatrix} (a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14},t) + (a''_{17})^{(2,2,)}(T_{17},t) + (a''_{21})^{(3,3,)}(T_{21},t) \\ + (a''_{25})^{(4,4,4,4,)}(T_{25},t) + (a''_{29})^{(5,5,5,5,)}(T_{29},t) + (a''_{33})^{(6,6,6,6,)}(T_{33},t) \\ + (a''_{37})^{(7,7)}(T_{37},t) + (a''_{41})^{(8,8)}(T_{41},t) + (a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{14} \quad 56$$

$$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \begin{bmatrix} (a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14},t) + (a''_{18})^{(2,2,)}(T_{17},t) + (a''_{22})^{(3,3,)}(T_{21},t) \\ + (a''_{26})^{(4,4,4,4,)}(T_{25},t) + (a''_{30})^{(5,5,5,5,)}(T_{29},t) + (a''_{34})^{(6,6,6,6,)}(T_{33},t) \\ + (a''_{38})^{(7,7)}(T_{37},t) + (a''_{42})^{(8,8)}(T_{41},t) + (a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{15} \quad 57$$

Where $(a''_{13})^{(1)}(T_{14},t)$, $(a''_{14})^{(1)}(T_{14},t)$, $(a''_{15})^{(1)}(T_{14},t)$ are first augmentation coefficients for category 1, 2 and 3

$+(a''_{16})^{(2,2,)}(T_{17},t)$, $+(a''_{17})^{(2,2,)}(T_{17},t)$, $+(a''_{18})^{(2,2,)}(T_{17},t)$ are second augmentation coefficient for category 1, 2 and 3

$+(a''_{20})^{(3,3,)}(T_{21},t)$, $+(a''_{21})^{(3,3,)}(T_{21},t)$, $+(a''_{22})^{(3,3,)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3

$+(a''_{24})^{(4,4,4,4,)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3

$+(a''_{28})^{(5,5,5,5,)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3

$+(a''_{32})^{(6,6,6,6,)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3

$+(a''_{38})^{(7,7)}(T_{37},t)$ $+(a''_{37})^{(7,7)}(T_{37},t)$ $+(a''_{36})^{(7,7)}(T_{37},t)$ are seventh augmentation coefficient for 1,2,3

$+(a''_{40})^{(8,8)}(T_{41},t)$ $+(a''_{41})^{(8,8)}(T_{41},t)$ $+(a''_{42})^{(8,8)}(T_{41},t)$ are eight augmentation coefficient for 1,2,3

$+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} - (b''_{13})^{(1)}(G,t) - (b''_{16})^{(2,2,)}(G_{19},t) - (b''_{20})^{(3,3,)}(G_{23},t) \\ - (b''_{24})^{(4,4,4,4,)}(G_{27},t) - (b''_{28})^{(5,5,5,5,)}(G_{31},t) - (b''_{32})^{(6,6,6,6,)}(G_{35},t) \\ - (b''_{36})^{(7,7,)}(G_{39},t) - (b''_{40})^{(8,8)}(G_{43},t) - (b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{13} \quad 58$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} - (b''_{14})^{(1)}(G,t) - (b''_{17})^{(2,2,)}(G_{19},t) - (b''_{21})^{(3,3,)}(G_{23},t) \\ - (b''_{25})^{(4,4,4,4,)}(G_{27},t) - (b''_{29})^{(5,5,5,5,)}(G_{31},t) - (b''_{33})^{(6,6,6,6,)}(G_{35},t) \\ - (b''_{37})^{(7,7,)}(G_{39},t) - (b''_{41})^{(8,8)}(G_{43},t) - (b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{14} \quad 59$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} - (b''_{15})^{(1)}(G,t) - (b''_{18})^{(2,2,)}(G_{19},t) - (b''_{22})^{(3,3,)}(G_{23},t) \\ - (b''_{26})^{(4,4,4,4,)}(G_{27},t) - (b''_{30})^{(5,5,5,5,)}(G_{31},t) - (b''_{34})^{(6,6,6,6,)}(G_{35},t) \\ - (b''_{38})^{(7,7,)}(G_{39},t) - (b''_{42})^{(8,8)}(G_{43},t) - (b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{15} \quad 60$$

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16} \quad 61$$

$$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{17} \quad 62$$

$$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{18} \quad 63$$

Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation

coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \begin{bmatrix} (b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\ \boxed{-(b''_{13})^{(1,1,)}(G,t)}\ \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{16} \quad 64$$

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \begin{bmatrix} (b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\ \boxed{-(b''_{14})^{(1,1,)}(G,t)}\ \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{17} \quad 65$$

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b'_{18})^{(2)}\boxed{-(b''_{18})^{(2)}(G_{19},t)}\ \boxed{-(b''_{15})^{(1,1,)}(G,t)}\ \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18} \quad 66$$

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t) + (a''_{16})^{(2,2,2)}(T_{17},t) + (a''_{13})^{(1,1,1,)}(T_{14},t) \\ + (a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ + (a''_{36})^{(7,7,7,7,7)}(T_{37},t) + (a''_{40})^{(8,8,8,8)}(T_{41},t) + (a''_{44})^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{matrix} (a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t) + (a''_{17})^{(2,2,2)}(T_{17},t) + (a''_{14})^{(1,1,1,)}(T_{14},t) \\ + (a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ + (a''_{37})^{(7,7,7,7,7)}(T_{37},t) + (a''_{41})^{(8,8,8,8)}(T_{41},t) + (a''_{45})^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{matrix} (a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t) + (a''_{18})^{(2,2,2)}(T_{17},t) + (a''_{15})^{(1,1,1,)}(T_{14},t) \\ + (a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t) + (a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t) + (a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t) \\ + (a''_{38})^{(7,7,7,7,7)}(T_{37},t) + (a''_{42})^{(8,8,8,8)}(T_{41},t) + (a''_{46})^{(9,9,9)}(T_{45},t) \end{matrix}\right] G_{22}$	69
$+(a''_{20})^{(3)}(T_{21},t)$, $+(a''_{21})^{(3)}(T_{21},t)$, $+(a''_{22})^{(3)}(T_{21},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{16})^{(2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2)}(T_{17},t)$ are second augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,)}(T_{14},t)$ are third augmentation coefficients for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3 $+(a''_{40})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3 $+(a''_{44})^{(9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t) - (b''_{16})^{(2,2,2)}(G_{19},t) - (b''_{13})^{(1,1,1,)}(G,t) \\ -(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t) - (b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t) - (b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t) \\ - (b''_{36})^{(7,7,7,7,7)}(G_{39},t) - (b''_{40})^{(8,8,8,8)}(G_{43},t) - (b''_{44})^{(9,9,9)}(G_{47},t) \end{matrix}\right] T_{20}$	70
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t) - (b''_{17})^{(2,2,2)}(G_{19},t) - (b''_{14})^{(1,1,1,)}(G,t) \\ -(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t) - (b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t) - (b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t) \\ - (b''_{37})^{(7,7,7,7,7)}(G_{39},t) - (b''_{41})^{(8,8,8,8)}(G_{43},t) - (b''_{45})^{(9,9,9)}(G_{47},t) \end{matrix}\right] T_{21}$	71

$$\frac{dT_{22}}{dt}=(b_{22})^{(3)}T_{21}-\begin{bmatrix}(b'_{22})^{(3)}\boxed{-(b''_{22})^{(3)}(G_{23},t)}\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}\end{bmatrix}T_{22}$$ 72

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\begin{bmatrix}(a'_{24})^{(4)}\boxed{+(a''_{24})^{(4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{24}$$ 73

$$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\begin{bmatrix}(a'_{25})^{(4)}\boxed{+(a''_{25})^{(4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{25}$$ 74

$$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\begin{bmatrix}(a'_{26})^{(4)}\boxed{+(a''_{26})^{(4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{26}$$ 75

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1,2\ \ 3$

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ $are\ second\ \ augmentation\ coefficient\ \ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ \ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$

$+(a''_{13})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1)}(T_{14},t)$

are fourth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{16})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2)}(T_{17},t)$

are fifth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{20})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3)}(T_{21},t)$

are sixth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)$

are seventh augmentation coefficients for category 1, 2 *and* 3

$+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)$

are eighth augmentation coefficients for category 1, 2 *and* 3

$+(a''_{46})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9)}(T_{45},t)$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)} \boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $-(b''_{24})^{(4)}(G_{27},t)$, $-(b''_{25})^{(4)}(G_{27},t)$, $-(b''_{26})^{(4)}(G_{27},t)$ *are first detrition coefficients for category* 1, 2 *and* 3

$-(b''_{28})^{(5,5,)}(G_{31},t)$, $-(b''_{29})^{(5,5,)}(G_{31},t)$, $-(b''_{30})^{(5,5,)}(G_{31},t)$ *are second detrition coefficients for category* 1, 2 *and* 3

$-(b''_{32})^{(6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,)}(G_{35},t)$, $-(b''_{34})^{(6,6,)}(G_{35},t)$ *are third detrition coefficients for category* 1, 2 *and* 3

$-(b''_{13})^{(1,1,1,1)}(G,t)$, $-(b''_{14})^{(1,1,1,1)}(G,t)$, $-(b''_{15})^{(1,1,1,1)}(G,t)$

are fourth detrition coefficients for category 1, 2 *and* 3

$-(b''_{16})^{(2,2,2,2)}(G_{19},t)$, $-(b''_{17})^{(2,2,2,2)}(G_{19},t)$, $-(b''_{18})^{(2,2,2,2)}(G_{19},t)$

are fifth detrition coefficients for category 1, 2 *and* 3

$-(b''_{20})^{(3,3,3,3)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,3)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,3)}(G_{23},t)$

are sixth detrition coefficients for category 1, 2 *and* 3

$-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)$

are seventh detrition coefficients for category 1, 2 *and* 3

$-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\begin{bmatrix}(a'_{28})^{(5)}\boxed{+(a''_{28})^{(5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{28}$	79
$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\begin{bmatrix}(a'_{29})^{(5)}\boxed{+(a''_{29})^{(5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{29}$	80
$\frac{dG_{30}}{dt}=(a_{30})^{(5)}G_{29}-\begin{bmatrix}(a'_{30})^{(5)}\boxed{+(a''_{30})^{(5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}\end{bmatrix}G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\begin{bmatrix}(b'_{28})^{(5)}\boxed{-(b''_{28})^{(5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{28}$	82
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\begin{bmatrix}(b'_{29})^{(5)}\boxed{-(b''_{29})^{(5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{29}$	83

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30} \quad 84$$

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32} \quad 85$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33} \quad 86$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34} \quad 87$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation*

$coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$

seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$

Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}, \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}, \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{34} \quad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}, \boxed{-(b''_{33})^{(6)}(G_{35},t)}, \boxed{-(b''_{34})^{(6)}(G_{35},t)}$ $are\ first\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}, \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}, \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ $are\ second\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}, \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}, \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ $are\ third\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}, \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}, \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}, \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}, \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}, \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}, \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}, \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}, \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad 91$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14} \quad 92$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \quad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$

are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = \quad 94$$

$(b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	
$\frac{dT_{37}}{dt} =$ $(b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} =$ $(b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$$(b_{41})^{(8)}T_{40} - \begin{bmatrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{42}}{dt} =$$

$$(b_{42})^{(8)}T_{41} - \begin{bmatrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \begin{bmatrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \begin{bmatrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{14}$$

$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{array}{l} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{array} \right] G_{15}$	
Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[\begin{array}{l} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{array} \right] T_{13}$	
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[\begin{array}{l} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{array} \right] T_{14}$	
$\frac{dT_{46}}{dt} =$	

$(b_{46})^{(9)}T_{45}-\left[\begin{array}{ccc}(b'_{46})^{(9)}\boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}\end{array}\right]T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)},(a'_i)^{(1)},(a''_i)^{(1)},(b_i)^{(1)},(b'_i)^{(1)},(b''_i)^{(1)}>0,\quad i,j=13,14,15$ The functions $(a''_i)^{(1)},(b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)},\ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t)\leq(p_i)^{(1)}\leq(\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t)\leq\ (r_i)^{(1)}\leq(b'_i)^{(1)}\leq(\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t)=(p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t)=\ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)},(p_i)^{(1)},\ (r_i)^{(1)}}$ are positive constants and $\boxed{i=13,14,15}$	98
They satisfy Lipschitz condition:	99

$\|(a_i^{''})^{(1)}(T_{14}^{'},t)-(a_i^{''})^{(1)}(T_{14},t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14}-T_{14}^{'}\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b_i^{''})^{(1)}(G^{'},t)-(b_i^{''})^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G-G^{'}\|\|e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(1)}(T_{14}^{'},t)$ and $(a_i^{''})^{(1)}(T_{14},t)$. $(T_{14}^{'},t)$ and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i^{''})^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i^{''})^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i^{'})^{(1)},(b_i)^{(1)},(b_i^{'})^{(1)},(p_i)^{(1)}, (r_i)^{(1)}, i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i^{'})^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i^{'})^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)},(a_i^{'})^{(2)},(a_i^{''})^{(2)},(b_i)^{(2)},(b_i^{'})^{(2)},(b_i^{''})^{(2)} > 0, \quad i,j=16,17,18$	
The functions $(a_i^{''})^{(2)},(b_i^{''})^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i^{''})^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i^{'})^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i^{''})^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i^{''})^{(2)}((G_{19}),t)= (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)}, (r_i)^{(2)}$ are positive constants and $i=16,17,18$	106
They satisfy Lipschitz condition:	

$\lvert(a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)}+(a_i')^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i')^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)},\ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21},t)\leq(p_i)^{(3)}\leq(\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t)\leq\ (r_i)^{(3)}\leq(b_i')^{(3)}\leq(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}(T_{21},t)=(p_i)^{(3)}$ $\mathrm{lim}_{\mathrm{G}\to\infty}(b_i'')^{(3)}(G_{23},t)=\ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}}$ are positive constants and $\boxed{i=20,21,22}$	113

They satisfy Lipschitz condition: $\lvert(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)\rvert \leq (\hat{k}_{20})^{(3)}\lvert T_{21}-T_{21}'\rvert e^{-(\hat{M}_{20})^{(3)}t}$ $\lvert(b_i'')^{(3)}(G_{23}',t)-(b_i'')^{(3)}(G_{23},t)\rvert < (\hat{k}_{20})^{(3)}\lvert\lvert G_{23}-G_{23}'\rvert\rvert e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and$(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}$, $\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}}<1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[\,(a_i)^{(3)}+(a_i')^{(3)}+\ (\hat{A}_{20})^{(3)}+\ (\hat{P}_{20})^{(3)}\,(\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[\ (b_i)^{(3)}+(b_i')^{(3)}+\ (\hat{B}_{20})^{(3)}+\ (\hat{Q}_{20})^{(3)}\ (\hat{k}_{20})^{(3)}]<1$	116
Where we suppose	
$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)}>0,\quad i,j=24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t)\leq(p_i)^{(4)}\leq(\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t)\leq\ (r_i)^{(4)}\leq(b_i')^{(4)}\leq(\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t)=\ (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}}$ are positive constants and $\boxed{i=24,25,26}$	118
They satisfy Lipschitz condition:	119

$\lvert(a_i^{''})^{(4)}(T_{25}^{'},t)-(a_i^{''})^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}^{'}\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i^{''})^{(4)}((G_{27})^{'},t)-(b_i^{''})^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})^{'}\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ and $(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ and (T_{25},t) are points belonging to the interval $[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}$, $\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
<u>Definition of</u> $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i^{'})^{(4)},(b_i)^{(4)},(b_i^{'})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}, i=24,25,26$, satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)}+(a_i^{'})^{(4)}+(\hat{A}_{24})^{(4)}+(\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)}+(b_i^{'})^{(4)}+(\hat{B}_{24})^{(4)}+(\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i^{'})^{(5)},(a_i^{''})^{(5)},(b_i)^{(5)},(b_i^{'})^{(5)},(b_i^{''})^{(5)}>0,\quad i,j=28,29,30$ The functions $(a_i^{''})^{(5)},(b_i^{''})^{(5)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(5)},\ (r_i)^{(5)}$: $(a_i^{''})^{(5)}(T_{29},t)\leq(p_i)^{(5)}\leq(\hat{A}_{28})^{(5)}$ $(b_i^{''})^{(5)}((G_{31}),t)\leq\ (r_i)^{(5)}\leq(b_i^{'})^{(5)}\leq(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t)=\ (r_i)^{(5)}$ **<u>Definition of</u>** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123

They satisfy Lipschitz condition: $\|(a_i^{''})^{(5)}(T_{29}^{'},t)-(a_i^{''})^{(5)}(T_{29},t)\| \leq (\hat{k}_{28})^{(5)}\|T_{29}-T_{29}^{'}\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i^{''})^{(5)}((G_{31})^{'},t)-(b_i^{''})^{(5)}((G_{31}),t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31})-(G_{31})^{'}\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ and $(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
<u>**Definition of**</u> $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i^{'})^{(5)},(b_i)^{(5)},(b_i^{'})^{(5)},(p_i)^{(5)}, (r_i)^{(5)}, i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)}+(a_i^{'})^{(5)}+(\hat{A}_{28})^{(5)}+(\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)}+(b_i^{'})^{(5)}+(\hat{B}_{28})^{(5)}+(\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i^{'})^{(6)},(a_i^{''})^{(6)},(b_i)^{(6)},(b_i^{'})^{(6)},(b_i^{''})^{(6)}>0, \quad i,j=32,33,34$ The functions $(a_i^{''})^{(6)},(b_i^{''})^{(6)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i^{''})^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i^{''})^{(6)}((G_{35}),t) \leq (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
$lim_{T_2\to\infty}(a_i^{''})^{(6)}(T_{33},t)=(p_i)^{(6)}$ $\lim_{G\to\infty}(b_i^{''})^{(6)}((G_{35}),t)=(r_i)^{(6)}$ <u>**Definition of**</u> $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$:	128

Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}', t) - (a_i'')^{(6)}(T_{33}, t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i'')^{(6)}((G_{35})', t) - (b_i'')^{(6)}((G_{35}), t)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>**Definition of**</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)} (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(QQQQQQQQ) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i, j = 36,37,38$ (RRRRRRRR) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq \ (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(SSSSSSSS) $\lim_{T_2 \to \infty} (a_i'')^{(7)} (T_{37}, t) = (p_i)^{(7)}$ *(TTTTTTTT)* $\lim_{G \to \infty} (b_i'')^{(7)} ((G_{39}), t) = \ (r_i)^{(7)}$	132

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$	
They satisfy Lipschitz condition: $\|(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\| \leq (\hat{k}_{36})^{(7)}\|T_{37} - T_{37}'\|e^{-(\hat{M}_{36})^{(7)}t}$ $\|(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\| < (\hat{k}_{36})^{(7)}\|\|(G_{39}) - (G_{39})'\|\|e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (UUUUUUUU) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (VVVVVVVV) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$	135
Where we suppose	
$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i, j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138

$(b_i'')^{(8)}((G_{43}),t) \leq \ (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty} (a_i'')^{(8)} (T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty} (b_i'')^{(8)} \left((G_{43}),t\right) = \ (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)},\ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t) - (a_i'')^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}\left((G_{43}),t\right)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)},$ are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}} \ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)},\ (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[\,(a_i)^{(8)} + (a_i')^{(8)} + \ (\hat{A}_{40})^{(8)} + \ (\hat{P}_{40})^{(8)}\ (\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[\ (b_i)^{(8)} + (b_i')^{(8)} + \ (\hat{B}_{40})^{(8)} + \ (\hat{Q}_{40})^{(8)}\ \ (\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$$(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$$

$$(b_i^{''})^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$$

$$\lim_{T_2\to\infty} (a_i^{''})^{(9)} (T_{45},t) = (p_i)^{(9)}$$

$$\lim_{G\to\infty} (b_i^{''})^{(9)} (G_{47},t) = (r_i)^{(9)}$$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$$|(a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}^{'}|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})^{'}||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $\left[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\right]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i^{'})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)} (\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i^{'})^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)} (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions 147

Definition of $G_i(0)$, $T_i(0)$:

$$G_i(t) \leq \left(\hat{P}_{13} \right)^{(1)} e^{(\hat{M}_{13})^{(1)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 148

Definition of $G_i(0)$, $T_i(0)$

$$G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t} \quad , \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t} \quad , \quad T_i(0) = T_i^0 > 0$$

Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 149

$$G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t} \quad , \quad G_i(0) = G_i^0 > 0$$

$$T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t} \quad , \quad T_i(0) = T_i^0 > 0$$

Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 150

Definition of $G_i(0)$, $T_i(0)$:

$$G_i(t) \leq \left(\hat{P}_{24} \right)^{(4)} e^{(\hat{M}_{24})^{(4)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 151

Definition of $G_i(0)$, $T_i(0)$:

$$G_i(t) \leq \left(\hat{P}_{28} \right)^{(5)} e^{(\hat{M}_{28})^{(5)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions 152

Definition of $G_i(0)$, $T_i(0)$:

$$G_i(t) \leq \left(\hat{P}_{32} \right)^{(6)} e^{(\hat{M}_{32})^{(6)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions 153

Definition of $G_i(0)$, $T_i(0)$:

$G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{13})^{(1)}, T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)}(T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i:\mathbb{R}_+\to\mathbb{R}_+$ which satisfy	159
$G_i(0)=G_i^0\,,\,T_i(0)=T_i^0\,,\,G_i^0\leq(\hat{P}_{16})^{(2)}\,,T_i^0\leq(\hat{Q}_{16})^{(2)},$	
$0\leq G_i(t)-G_i^0\leq(\hat{P}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$	
$0\leq T_i(t)-T_i^0\leq(\hat{Q}_{16})^{(2)}e^{(\hat{M}_{16})^{(2)}t}$	
By $\bar{G}_{16}(t)=G_{16}^0+\int_0^t\left[(a_{16})^{(2)}G_{17}\left(s_{(16)}\right)-\left((a_{16}^{'})^{(2)}+a_{16}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right),s_{(16)}\right)\right)G_{16}\left(s_{(16)}\right)\right]ds_{(16)}$	160
$\bar{G}_{17}(t)=G_{17}^0+\int_0^t\left[(a_{17})^{(2)}G_{16}\left(s_{(16)}\right)-\left((a_{17}^{'})^{(2)}+(a_{17}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right),s_{(17)}\right)\right)G_{17}\left(s_{(16)}\right)\right]ds_{(16)}$	
$\bar{G}_{18}(t)=G_{18}^0+\int_0^t\left[(a_{18})^{(2)}G_{17}\left(s_{(16)}\right)-\left((a_{18}^{'})^{(2)}+(a_{18}^{''})^{(2)}\left(T_{17}\left(s_{(16)}\right),s_{(16)}\right)\right)G_{18}\left(s_{(16)}\right)\right]ds_{(16)}$	
$\bar{T}_{16}(t)=T_{16}^0+\int_0^t\left[(b_{16})^{(2)}T_{17}\left(s_{(16)}\right)-\left((b_{16}^{'})^{(2)}-(b_{16}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right),s_{(16)}\right)\right)T_{16}\left(s_{(16)}\right)\right]ds_{(16)}$	
$\bar{T}_{17}(t)=T_{17}^0+\int_0^t\left[(b_{17})^{(2)}T_{16}\left(s_{(16)}\right)-\left((b_{17}^{'})^{(2)}-(b_{17}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right),s_{(16)}\right)\right)T_{17}\left(s_{(16)}\right)\right]ds_{(16)}$	
$\bar{T}_{18}(t)=T_{18}^0+\int_0^t\left[(b_{18})^{(2)}T_{17}\left(s_{(16)}\right)-\left((b_{18}^{'})^{(2)}-(b_{18}^{''})^{(2)}\left(G_{19}\left(s_{(16)}\right),s_{(16)}\right)\right)T_{18}\left(s_{(16)}\right)\right]ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i:\mathbb{R}_+\to\mathbb{R}_+$ which satisfy	
$G_i(0)=G_i^0\,,\,T_i(0)=T_i^0\,,\,G_i^0\leq(\hat{P}_{20})^{(3)}\,,T_i^0\leq(\hat{Q}_{20})^{(3)},$	
$0\leq G_i(t)-G_i^0\leq(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$	
$0\leq T_i(t)-T_i^0\leq(\hat{Q}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}t}$	
By $\bar{G}_{20}(t)=G_{20}^0+\int_0^t\left[(a_{20})^{(3)}G_{21}\left(s_{(20)}\right)-\left((a_{20}^{'})^{(3)}+a_{20}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right),s_{(20)}\right)\right)G_{20}\left(s_{(20)}\right)\right]ds_{(20)}$	161
$\bar{G}_{21}(t)=G_{21}^0+\int_0^t\left[(a_{21})^{(3)}G_{20}\left(s_{(20)}\right)-\left((a_{21}^{'})^{(3)}+(a_{21}^{''})^{(3)}\left(T_{21}\left(s_{(20)}\right),s_{(20)}\right)\right)G_{21}\left(s_{(20)}\right)\right]ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)}G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right)G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)}T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right)T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)}T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right)T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)}T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right)T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)}G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right)G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)}G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right)G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)}G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right)G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)}T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right)T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)}T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right)T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)}T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right)T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}')^{(5)} + a_{28}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}')^{(5)} - (b_{28}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}')^{(5)} - (b_{29}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}')^{(5)} - (b_{30}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{32})^{(6)}, T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}')^{(6)} - (b_{33}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}')^{(6)} - (b_{34}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,, \, T_i(0) = T_i^0 \,, \, G_i^0 \leq (\hat{P}_{36})^{(7)} \,, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,, \, T_i(0) = T_i^0 \,, \, G_i^0 \leq (\hat{P}_{40})^{(8)} \,, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}')^{(8)} - (b_{40}'')^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}')^{(8)} - (b_{41}'')^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}')^{(8)} - (b_{42}'')^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$,$T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}')^{(9)} + a_{44}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}')^{(9)} - (b_{44}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}')^{(9)} - (b_{45}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}')^{(9)} - (b_{46}'')^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that	168

$(G_{13}(t) - G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)}\left(G_{17}^0 + (\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)}t\right)G_{17}^0 + \frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)}\left(G_{21}^0 + (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)}t\right)G_{21}^0 + \frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t} - 1\right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{P}_{20})^{(3)} + G_{21}^0\right)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)} + (\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)}\left(G_{25}^0 + (\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)}t\right)G_{25}^0 + \frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t} - 1\right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)} + G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)} + (\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176
From which it follows that $(G_{32}(t) - G_{32}^0) e^{-(\hat{M}_{32})^{(6)} t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left[\left((\hat{P}_{32})^{(6)} + G_{33}^0 \right) e^{\left(-\frac{(\hat{P}_{32})^{(6)} + G_{33}^0}{G_{33}^0} \right)} + (\hat{P}_{32})^{(6)} \right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(hh) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} \left(G_{37}^0 + (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} s_{(36)}} \right) \right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)} t\right) G_{37}^0 + \frac{(a_{36})^{(7)} (\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left(e^{(\hat{M}_{36})^{(7)} t} - 1 \right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0) e^{-(\hat{M}_{36})^{(7)} t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left[\left((\hat{P}_{36})^{(7)} + G_{37}^0 \right) e^{\left(-\frac{(\hat{P}_{36})^{(7)} + G_{37}^0}{G_{37}^0} \right)} + (\hat{P}_{36})^{(7)} \right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}} \right) \right] ds_{(40)} =$	180

$\left(1+(a_{40})^{(8)}t\right)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41}, G_{42}, T_{40}, T_{41}, T_{42}	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t)\leq G_{44}^0+\int_0^t\left[(a_{44})^{(9)}\left(G_{45}^0+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right]ds_{(44)}=$ $\left(1+(a_{44})^{(9)}t\right)G_{45}^0+\frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$	
From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t}\leq\frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45}, G_{46}, T_{44}, T_{45}, T_{46}	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)}+\left((\hat{P}_{13})^{(1)}+G_j^0\right)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{Q}_{13})^{(1)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{13})^{(1)}\right]\leq(\hat{Q}_{13})^{(1)}$	184
In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left(\left(G^{(1)},T^{(1)}\right),\left(G^{(2)},T^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{13})^{(1)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{13})^{(1)}t}\}$	185

Indeed if we denote **Definition of** $\tilde{G}, \tilde{T}$: $(\tilde{G}, \tilde{T}) = \mathcal{A}^{(1)}(G, T)$ It results $\left\|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\right\| \leq \int_0^t (a_{13})^{(1)} \left\|G_{14}^{(1)} - G_{14}^{(2)}\right\| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}}\, ds_{(13)} +$ $\int_0^t \{(a_{13}^{'})^{(1)} \left\|G_{13}^{(1)} - G_{13}^{(2)}\right\| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} +$ $(a_{13}^{''})^{(1)}(T_{14}^{(1)}, s_{(13)}) \left\|G_{13}^{(1)} - G_{13}^{(2)}\right\| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} +$ $G_{13}^{(2)} \left\|(a_{13}^{''})^{(1)}(T_{14}^{(1)}, s_{(13)}) - (a_{13}^{''})^{(1)}(T_{14}^{(2)}, s_{(13)})\right\|\ e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}}\} ds_{(13)}$ Where $s_{(13)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$ From the hypotheses it follows	
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In the same way , one can obtain $G_{22} \leq \left((\widehat{M}_{20})^{(3)}\right)_3 = G_{22}^0 + 2(a_{22})^{(3)}\left((\widehat{M}_{20})^{(3)}\right)_2/(a_{22}^{'})^{(3)}$ If G_{21} *or* G_{22} is bounded, the same property follows for G_{20} , G_{22} and G_{20} , G_{21} respectively.	
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Indeed if we denote

Definition of $\widetilde{(G_{27})}, \widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})}, \widetilde{(T_{27})} \right) = \mathcal{A}^{(4)}((G_{27}), (T_{27}))$

It results

$$\left|\tilde{G}_{24}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{24})^{(4)} \left|G_{25}^{(1)} - G_{25}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \, ds_{(24)} +$$

$$\int_0^t \{(a_{24}^{'})^{(4)} \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$(a_{24}^{''})^{(4)} \left(T_{25}^{(1)}, s_{(24)}\right) \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$G_{24}^{(2)} |(a_{24}^{''})^{(4)} \left(T_{25}^{(1)}, s_{(24)}\right) - (a_{24}^{''})^{(4)} \left(T_{25}^{(2)}, s_{(24)}\right)| \; e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \} ds_{(24)}$$

Where $s_{(24)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on Equations it follows

$$\left|(G_{27})^{(1)} - (G_{27})^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} t} \leq$$
$$\frac{1}{(\widehat{M}_{24})^{(4)}} \left((a_{24})^{(4)} + (a_{24}^{'})^{(4)} + (\widehat{A}_{24})^{(4)} + (\widehat{P}_{24})^{(4)} (\widehat{k}_{24})^{(4)}\right) d\left(\left((G_{27})^{(1)}, (T_{27})^{(1)}; (G_{27})^{(2)}, (T_{27})^{(2)}\right)\right)$$ 226

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 16: The fact that we supposed $(a_{24}^{''})^{(4)}$ and $(b_{24}^{''})^{(4)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ *and* $(\widehat{Q}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ respectively of $\mathbb{R}_+$. 227

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(4)}$ and $(b_i^{''})^{(4)}, i = 24,25,26$ depend only on T_{25} and respectively on (G_{27})(*and not on t*) and hypothesis can replaced by a usual Lipschitz condition.

Remark 17: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$ 228

it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(4)} - (a_i^{''})^{(4)} (T_{25}(s_{(24)}), s_{(24)})\} ds_{(24)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(4)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{24})^{(4)}\right)_1, \left((\widehat{M}_{24})^{(4)}\right)_2$ *and* $\left((\widehat{M}_{24})^{(4)}\right)_3$: 229

Remark 18: if G_{24} is bounded, the same property have also G_{25} *and* G_{26} . indeed if

$G_{24} < (\widehat{M}_{24})^{(4)}$ it follows $\frac{dG_{25}}{dt} \leq \left((\widehat{M}_{24})^{(4)}\right)_1 - (a_{25}^{'})^{(4)} G_{25}$ and by integrating

$$G_{25} \leq \left((\widehat{M}_{24})^{(4)}\right)_2 = G_{25}^0 + 2(a_{25})^{(4)} \left((\widehat{M}_{24})^{(4)}\right)_1 / (a_{25}^{'})^{(4)}$$

In the same way , one can obtain $G_{26} \leq \left((\widehat{M}_{24})^{(4)}\right)_3 = G_{26}^0 + 2(a_{26})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_2/(a_{26}^{'})^{(4)}$ If G_{25} *or* G_{26} is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.	
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Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
$\lvert(G_{43})^{(1)}-(G_{43})^{(2)}\rvert e^{-(\widehat{M}_{40})^{(8)}t}\leq$ $\frac{1}{(\widehat{M}_{40})^{(8)}}\left((a_{40})^{(8)}+(a_{40}')^{(8)}+(\widehat{A}_{40})^{(8)}+(\widehat{P}_{40})^{(8)}(\widehat{k}_{40})^{(8)}\right)d\left(\left((G_{43})^{(1)},(T_{43})^{(1)};\;(G_{43})^{(2)},(T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
Remark 36: The fact that we supposed $(a_{40}'')^{(8)}$ and $(b_{40}'')^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ *and* $(\widehat{Q}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i=40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
Remark 37 There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$	275

it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(8)} - (a_i^{''})^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(8)} t)} > 0$ for $t > 0$	
Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}^{'})^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}^{'})^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}^{'})^{(8)}$ If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	276
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(8)}((G_{43})(t),t)) = (b_{41}^{'})^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i^{''})^{(8)}\left((G_{43})(t),t\right) < \varepsilon_8, T_{40}\,(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}^{''})^{(8)}\left((G_{43})(t), t(t), t\right) = (b_{42}^{'})^{(8)}$	279
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have	279 A

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(\left((G_{47})^{(1)},(T_{47})^{(1)}\right),\left((G_{47})^{(2)},(T_{47})^{(2)}\right)\right) =$$
$$\sup_i\{\max_{t\in\mathbb{R}_+} \left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+} \left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})},\widetilde{(T_{47})} : (\widetilde{(G_{47})},\widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}),(T_{47}))$
It results

$$\left|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{44})^{(9)} \left|G_{45}^{(1)} - G_{45}^{(2)}\right| e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{(\hat{M}_{44})^{(9)}s_{(44)}}\, ds_{(44)} +$$
$$\int_0^t \{(a'_{44})^{(9)}\left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{-(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right)\left|G_{44}^{(1)} - G_{44}^{(2)}\right| e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{(\hat{M}_{44})^{(9)}s_{(44)}} +$$
$$G_{44}^{(2)}\left|(a''_{44})^{(9)}\left(T_{45}^{(1)}, s_{(44)}\right) - (a''_{44})^{(9)}\left(T_{45}^{(2)}, s_{(44)}\right)\right|\ e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{(\hat{M}_{44})^{(9)}s_{(44)}}\} ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)} - G^{(2)}\right| e^{-(\hat{M}_{44})^{(9)}t} \leq$$
$$\frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)} + (a'_{44})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(\left((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)}\right)\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ *and* $(\hat{Q}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on t*) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(9)} - (a_i^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i^{'})^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}^{'})^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}^{'})^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}^{'})^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(9)}((G_{47})(t), t)) = (b_{45}^{'})^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i^{''})^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}^{''})^{(9)}((G_{47})(t), t) = (b_{46}^{'})^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} - (a_{13}^{''})^{(1)}(T_{14}, t) + (a_{14}^{''})^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G,t) - (b''_{14})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$ and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a'_{15})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}\right] + G_{15}^0 e^{-(a'_{15})^{(1)}t}\right)$	286

$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b'_{15})^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b'_{15})^{(1)}t}\right] + T_{15}^0 e^{-(b'_{15})^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a'_{13})^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b'_{13})^{(1)}$ $(R_2)^{(1)} = (b'_{15})^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}((G_{19}), t) - (b''_{17})^{(2)}((G_{19}), t) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}(u^{(2)})^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}(u^{(2)})^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
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$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq \right.$ $\left.\frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}^{'})^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}^{'})^{(2)}t}\right] + G_{18}^0 e^{-(a_{18}^{'})^{(2)}t}\right)$	312
$T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}^{'})^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}^{'})^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}^{'})^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}^{'})^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b'_{16})^{(2)}$ $(R_2)^{(2)} = (b'_{18})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a'_{20})^{(3)} + (a'_{21})^{(3)} - (a''_{20})^{(3)}(T_{21}, t) + (a''_{21})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b'_{20})^{(3)} + (b'_{21})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) - (b''_{21})^{(3)}((G_{23}), t) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)}, \; \boldsymbol{if} \; (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}, \boldsymbol{if} \; (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}, \; \boldsymbol{if} \; (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if} \; (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$

Then the solution of global equations satisfies the inequalities

$G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$

$(p_i)^{(3)}$ is defined by equation

$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$ 323

$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ 324

$\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$

$T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$ 325

$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$ 326

$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ 327

$\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$

<u>**Definition of**</u> $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- 328

Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$

$(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$

$(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$

$(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$

<u>**Behavior of the solutions of equation**</u>

<u>**Theorem:**</u> If we denote and define

<u>**Definition of**</u> $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$:

$(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying

$-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$

$-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}\big((G_{27}), t\big) - (b_{25}'')^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$

<u>**Definition of**</u> $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: 329

By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations

$(a_{25})^{(4)}\left(v^{(4)}\right)^2 + (\sigma_1)^{(4)}v^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	
Definition of $(\bar{v}_1)^{(4)},, (\bar{v}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{v}_1)^{(4)} > 0$, $(\bar{v}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(v^{(4)}\right)^2 + (\sigma_2)^{(4)}v^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}, (v_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (v_0)^{(4)}, (m_1)^{(4)} = (v_1)^{(4)},\ \boldsymbol{if}\ (v_0)^{(4)} < (v_1)^{(4)}$ $(m_2)^{(4)} = (v_1)^{(4)}, (m_1)^{(4)} = (\bar{v}_1)^{(4)}$, $\boldsymbol{if}\ (v_4)^{(4)} < (v_0)^{(4)} < (\bar{v}_1)^{(4)}$, and $\boxed{(v_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (v_4)^{(4)}, (m_1)^{(4)} = (v_0)^{(4)},\ \boldsymbol{if}\ (\bar{v}_4)^{(4)} < (v_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0 e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}^{'})^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}^{'})^{(4)}$ $(R_2)^{(4)}=(b_{26}^{'})^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\leq-(a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}-(a_{28}^{''})^{(5)}(T_{29},t)+(a_{29}^{''})^{(5)}(T_{29},t)\leq-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\leq-(b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31}),t)-(b_{29}^{''})^{(5)}((G_{31}),t)\leq-(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},,(\bar{\nu}_2)^{(5)},(\bar{u}_1)^{(5)},(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)}>0,(\bar{\nu}_2)^{(5)}<0$ and respectively $(\bar{u}_1)^{(5)}>0,(\bar{u}_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar{\nu}_1)^{(5)},\boldsymbol{if}\ (\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}, \ \boldsymbol{if} \ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)} \ , \boldsymbol{if} \ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$ and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if} \ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)} t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)} t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)} t}\right] + G_{30}^0 e^{-(S_2)^{(5)} t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b'_{30})^{(5)})}\left[e^{(R_1)^{(5)} t} - e^{-(b'_{30})^{(5)} t}\right] + T_{30}^0 e^{-(b'_{30})^{(5)} t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)} t}\right] + T_{30}^0 e^{-(R_2)^{(5)} t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)} (m_2)^{(5)} - (a'_{28})^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)} (\mu_2)^{(5)} - (b'_{28})^{(5)}$ $(R_2)^{(5)} = (b'_{30})^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)}, , (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)},\ \boldsymbol{if}\ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)},\ \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^{0}e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^{0}e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}}T_{32}^{0}e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}}T_{32}^{0}e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)}T_{32}^{0}}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t}-e^{-(b_{34}')^{(6)}t}\right]+T_{34}^{0}e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)}T_{32}^{0}}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t}-e^{-(R_2)^{(6)}t}\right]+T_{34}^{0}e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37},t) + (a_{37}'')^{(7)}(T_{37},t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}),t) - (b_{37}'')^{(7)}((G_{39}),t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}(\nu^{(7)})^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}(u^{(7)})^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \le G_{36}(t) \le G_{36}^0 e^{(S_1)^{(7)} t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \le G_{37}(t) \le \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)} t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)} t}\right] + G_{38}^0 e^{-(S_2)^{(7)} t} \le G_{38}(t) \le\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)} t} - e^{-(a_{38}')^{(7)} t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)} t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)} t} \le T_{36}(t) \le T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)} t} \le T_{36}(t) \le \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})}\left[e^{(R_1)^{(7)} t} - e^{-(b_{38}')^{(7)} t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)} t} \le T_{38}(t) \le$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)} + (r_{36})^{(7)} + (R_2)^{(7)})}\left[e^{((R_1)^{(7)} + (r_{36})^{(7)})t} - e^{-(R_2)^{(7)} t}\right] + T_{38}^0 e^{-(R_2)^{(7)} t}$	369
<u>**Definition of**</u> $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)} (m_2)^{(7)} - (a_{36}')^{(7)}$	370

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$

$(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$

$(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$

Behavior of the solutions of equation 371

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$:

$(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying

$-(\sigma_2)^{(8)} \le -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \le -(\sigma_1)^{(8)}$

$-(\tau_2)^{(8)} \le -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \le -(\tau_1)^{(8)}$

Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: 372

By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$
and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and

Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$:

By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the

roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$

and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$

Definition of $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:-

If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by

$(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)} < (\nu_1)^{(8)}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)},\ \boldsymbol{if}\ (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$,
and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a'_{42})^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a'_{42})^{(8)}t}\right] + G_{42}^0 e^{-(a'_{42})^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\big(\nu^{(9)}\big)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\big(u^{(9)}\big)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if} \ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if} \ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

(

$\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0e^{-(S_2)^{(9)}t}\leq G_{46}(t)\leq$

$\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t}-e^{-(a_{46}')^{(9)}t}]+\ G_{46}^0e^{-(a_{46}')^{(9)}t})$

$\boxed{T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$

$\frac{1}{(\mu_1)^{(9)}}T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq\frac{1}{(\mu_2)^{(9)}}T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$

$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b_{46}')^{(9)}t}\right]+T_{46}^0e^{-(b_{46}')^{(9)}t}\leq T_{46}(t)\leq$

$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0e^{-(R_2)^{(9)}t}$

Definition of $(S_1)^{(9)},(S_2)^{(9)},(R_1)^{(9)},(R_2)^{(9)}$:-

Where $(S_1)^{(9)}=(a_{44})^{(9)}(m_2)^{(9)}-(a_{44}')^{(9)}$

$(S_2)^{(9)}=(a_{46})^{(9)}-(p_{46})^{(9)}$

$(R_1)^{(9)}=(b_{44})^{(9)}(\mu_2)^{(9)}-(b_{44}')^{(9)}$

$(R_2)^{(9)}=(b_{46}')^{(9)}-(r_{46})^{(9)}$

Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have	386

Definition of $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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In the same manner , we get	391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
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$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}^{'})^{(3)} - (a_{21}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right) - (a_{21}^{''})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
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In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
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$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$ if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{24}'')^{(4)} = (a_{25}'')^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b_{24}'')^{(4)} = (b_{25}'')^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}')^{(5)} - (a_{29}')^{(5)} + (a_{28}'')^{(5)}(T_{29},t)\right) - (a_{29}'')^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains **Definition of** $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:- For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$ $\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}$, $\boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$ it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$	
In the same manner , we get $\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}$, $\boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$ From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$	409
If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, $(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$	410
If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain $(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(5)}(t)$:- $(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}$, $\boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(5)}(t)$:- $(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$	411

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$ if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>**Proof**</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ <u>**Definition of**</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains <u>**Definition of**</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **<u>Definition of</u>** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
<u>Definition of</u> $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **<u>Particular case :</u>** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:-	424

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}^{''})^{(9)} = (a_{45}^{''})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}^{''})^{(9)} = (b_{45}^{''})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i^{''})^{(1)} and\ (b_i^{''})^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}^{'})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}^{'})^{(1)}(r_{14})^{(1)} - (b_{14}^{'})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

$with\ \ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i'')^{(6)} and\ (b_i'')^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}')^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}')^{(6)}(r_{33})^{(6)} - (b_{33}')^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ \ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ \ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) + (a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (hh) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) +$	486

$(a_{16}'')^{(2)}(T_{17})(a_{17}'')^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}')^{(3)}(a_{21}'')^{(3)}(T_{21}) + (a_{21}')^{(3)}(a_{20}'')^{(3)}(T_{21}) + (a_{20}'')^{(3)}(T_{21})(a_{21}'')^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}')^{(4)}(a_{25}'')^{(4)}(T_{25}) + (a_{25}')^{(4)}(a_{24}'')^{(4)}(T_{25}) + (a_{24}'')^{(4)}(T_{25})(a_{25}'')^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}')^{(5)}(a_{29}'')^{(5)}(T_{29}) + (a_{29}')^{(5)}(a_{28}'')^{(5)}(T_{29}) + (a_{28}'')^{(5)}(T_{29})(a_{29}'')^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}')^{(6)}(a_{33}'')^{(6)}(T_{33}) + (a_{33}')^{(6)}(a_{32}'')^{(6)}(T_{33}) + (a_{32}'')^{(6)}(T_{33})(a_{33}'')^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}')^{(7)}(a_{37}'')^{(7)}(T_{37}) + (a_{37}')^{(7)}(a_{36}'')^{(7)}(T_{37}) + (a_{36}'')^{(7)}(T_{37})(a_{37}'')^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}')^{(8)}(a_{41}'')^{(8)}(T_{41}) + (a_{41}')^{(8)}(a_{40}'')^{(8)}(T_{41}) + (a_{40}'')^{(8)}(T_{41})(a_{41}'')^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}')^{(9)}(a_{45}'')^{(9)}(T_{45}) + (a_{45}')^{(9)}(a_{44}'')^{(9)}(T_{45}) + (a_{44}'')^{(9)}(T_{45})(a_{45}'')^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^* :- 493

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^* for which $f(T_{14}^*) = 0$. With this value , we obtain from the three first equations

$$G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^*)]} \quad , \quad G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^*)]}$$

Definition and uniqueness of T_{17}^* :- 494

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^* for which $f(T_{17}^*) = 0$. With this value , we obtain from the three first equations

$$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^*)]} \quad , \quad G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^*)]}$$ 495

Definition and uniqueness of T_{21}^* :- 496

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^* for which $f(T_{21}^*) = 0$. With this value , we obtain from the three first equations

$$G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^*)]} \quad , \quad G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^*)]}$$

Definition and uniqueness of T_{25}^* :- 497

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^* for which $f(T_{25}^*) = 0$. With this value , we obtain from the three first equations

$$G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^*)]} \quad , \quad G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^*)]}$$

Definition and uniqueness of T_{29}^* :- 498

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^* for which $f(T_{29}^*) = 0$. With this value , we obtain from the three first equations

$$G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^*)]} \quad , \quad G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^*)]}$$

Definition and uniqueness of T_{33}^* :- 499

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^* for which $f(T_{33}^*) = 0$. With this value , we obtain from the three first equations

$G_{32} = \frac{(a_{32})^{(6)}G_{33}}{[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34} = \frac{(a_{34})^{(6)}G_{33}}{[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33}^*)]}$	
Definition and uniqueness of T_{37}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^* for which $f(T_{37}^*) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}')^{(7)}+(a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}')^{(7)}+(a_{38}'')^{(7)}(T_{37}^*)]}$	500
Definition and uniqueness of T_{41}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^* for which $f(T_{41}^*) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)}G_{41}}{[(a_{40}')^{(8)}+(a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42} = \frac{(a_{42})^{(8)}G_{41}}{[(a_{42}')^{(8)}+(a_{42}'')^{(8)}(T_{41}^*)]}$	501
Definition and uniqueness of T_{45}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^* for which $f(T_{45}^*) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)}G_{45}}{[(a_{44}')^{(9)}+(a_{44}'')^{(9)}(T_{45}^*)]}$, $G_{46} = \frac{(a_{46})^{(9)}G_{45}}{[(a_{46}')^{(9)}+(a_{46}'')^{(9)}(T_{45}^*)]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}')^{(1)}(b_{14}'')^{(1)}(G) + (b_{14}')^{(1)}(b_{13}'')^{(1)}(G)\right]+(b_{13}'')^{(1)}(G)(b_{14}'')^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}')^{(2)}(b_{17}'')^{(2)}(G_{19}) + (b_{17}')^{(2)}(b_{16}'')^{(2)}(G_{19})\right]+(b_{16}'')^{(2)}(G_{19})(b_{17}'')^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	
By the same argument, the equations admit solutions G_{20},G_{21} if $\varphi(G_{23})=(b_{20}')^{(3)}(b_{21}')^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23})+(b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right]+(b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20},G_{21},G_{22}),G_{20},G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24},G_{25} if $\varphi(G_{27})=(b_{24}')^{(4)}(b_{25}')^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27})+(b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right]+(b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24},G_{25},G_{26}),G_{24},G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28},G_{29} if $\varphi(G_{31})=(b_{28}')^{(5)}(b_{29}')^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31})+(b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right]+(b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28},G_{29},G_{30}),G_{28},G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32},G_{33} if $\varphi(G_{35})=(b_{32}')^{(6)}(b_{33}')^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35})+(b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right]+(b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32},G_{33},G_{34}),G_{32},G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi({G_{35}}^{*})=0$	508
By the same argument, the equations admit solutions G_{36},G_{37} if $\varphi(G_{39})=(b_{36}')^{(7)}(b_{37}')^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39})+(b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right]+(b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36},G_{37},G_{38}),G_{36},G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi({G_{39}}^{*})=0$	509
By the same argument, the equations admit solutions G_{40},G_{41} if	510

$\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*) = 0$	
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{45} such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G^*_{14} given by $\varphi(G^*) = 0$, T^*_{14} given by $f(T^*_{14}) = 0$ and $G^*_{13} = \frac{(a_{13})^{(1)}G^*_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G^*_{15} = \frac{(a_{15})^{(1)}G^*_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$ $T^*_{13} = \frac{(b_{13})^{(1)}T^*_{14}}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T^*_{15} = \frac{(b_{15})^{(1)}T^*_{14}}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G^*_{17} given by $\varphi((G_{19})^*) = 0$, T^*_{17} given by $f(T^*_{17}) = 0$ and	512
$G^*_{16} = \frac{(a_{16})^{(2)}G^*_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G^*_{18} = \frac{(a_{18})^{(2)}G^*_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	513
$T^*_{16} = \frac{(b_{16})^{(2)}T^*_{17}}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T^*_{18} = \frac{(b_{18})^{(2)}T^*_{17}}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G^*_{21} given by $\varphi((G_{23})^*) = 0$, T^*_{21} given by $f(T^*_{21}) = 0$ and $G^*_{20} = \frac{(a_{20})^{(3)}G^*_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G^*_{22} = \frac{(a_{22})^{(3)}G^*_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$ $T^*_{20} = \frac{(b_{20})^{(3)}T^*_{21}}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T^*_{22} = \frac{(b_{22})^{(3)}T^*_{21}}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}(\,(G_{19})^*\,) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}(\,(G_{23})^*\,) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b'_{21})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)} T_{21}^* \mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b'_{22})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)} T_{22}^* \mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(4)}$ *and* $(b''_i)^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{25})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b''_i)^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a'_{24})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)} G_{24}^* \mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a'_{25})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)} G_{25}^* \mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a'_{26})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)} G_{26}^* \mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)} T_{24}^* \mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)} T_{25}^* \mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)} T_{26}^* \mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(5)}$ *and* $(b''_i)^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{29})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b''_i)^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(6)}$ *and* $(b''_i)^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a''_{33})^{(6)}}{\partial T_{33}}(T_{33}^{*}) = (q_{33})^{(6)} \quad , \frac{\partial (b''_i)^{(6)}}{\partial G_j}\left((G_{35})^{*}\right) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ *and* $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j} ((G_{39})^{**}) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G_{36}^* \mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G_{37}^* \mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G_{38}^* \mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T_{36}^* \mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T_{37}^* \mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T_{38}^* \mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}} (T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j} ((G_{43})^*) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G_{40}^* \mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G_{41}^* \mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)} G_{42}^* \mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*} + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$$

$$+((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}) \left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(2)} + (b_{18}^{'})^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a_{18}^{'})^{(2)} + (p_{18})^{(2)})$$

$$\left[\left(\left((\lambda)^{(2)} + (a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*} + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)} + (a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*} + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right) (q_{18})^{(2)}\mathrm{G}_{18}$$

$$+((\lambda)^{(2)} + (a_{16}^{'})^{(2)} + (p_{16})^{(2)}) \left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(3)} + (b_{22}^{'})^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a_{22}^{'})^{(3)} + (p_{22})^{(3)})$$

$$\left[\left(\left((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)} + (a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*} + (a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2 + \left((b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)})s_{(21),(22)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\} = 0$ +	
$((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((b_{28}^{'})^{(5)} + (b_{29}^{'})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^2 + \left((a_{28}^{'})^{(5)} + (a_{29}^{'})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(30)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(6)} + (b_{34}^{'})^{(6)} - (r_{34})^{(6)})\{((\lambda)^{(6)} + (a_{34}^{'})^{(6)} + (p_{34})^{(6)})$$

$$\left[\left(((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)})(q_{33})^{(6)}G_{33}^{*} + (a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)})s_{(33),(33)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(((\lambda)^{(6)} + (a_{33}^{'})^{(6)} + (p_{33})^{(6)})(q_{32})^{(6)}G_{32}^{*} + (a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)})s_{(33),(32)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((b_{32}^{'})^{(6)} + (b_{33}^{'})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2 + \left((a_{32}^{'})^{(6)} + (a_{33}^{'})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+((\lambda)^{(6)} + (a_{32}^{'})^{(6)} + (p_{32})^{(6)})\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(((\lambda)^{(6)} + (b_{32}^{'})^{(6)} - (r_{32})^{(6)})s_{(33),(34)}T_{33}^{*} + (b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(7)} + (b_{38}^{'})^{(7)} - (r_{38})^{(7)})\{((\lambda)^{(7)} + (a_{38}^{'})^{(7)} + (p_{38})^{(7)})$$

$$\left[\left(((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)})(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)})s_{(37),(37)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$$+\left(((\lambda)^{(7)} + (a_{37}^{'})^{(7)} + (p_{37})^{(7)})(q_{36})^{(7)}G_{36}^{*} + (a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$$

$$\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)})s_{(37),(36)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right) (q_{38})^{(7)} G_{38}$$

$$+\left((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right) \left((a_{38})^{(7)}(q_{37})^{(7)} G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)} G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(38)} T_{37}^{*} + (b_{37})^{(7)} s_{(36),(38)} T_{36}^{*}\right)\} = 0$$

$+$

$$\left((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\{\left((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)(q_{41})^{(8)} G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)} G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right) s_{(41),(41)} T_{41}^{*} + (b_{41})^{(8)} s_{(40),(41)} T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)(q_{40})^{(8)} G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)} G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right) s_{(41),(40)} T_{41}^{*} + (b_{41})^{(8)} s_{(40),(40)} T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right) (q_{42})^{(8)} G_{42}$$

$$+\left((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right) \left((a_{42})^{(8)}(q_{41})^{(8)} G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)} G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right) s_{(41),(42)} T_{41}^{*} + (b_{41})^{(8)} s_{(40),(42)} T_{40}^{*}\right)\} = 0$$

$+$

$$\left((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\{\left((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)(q_{45})^{(9)} G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)} G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right) s_{(45),(45)} T_{45}^{*} + (b_{45})^{(9)} s_{(44),(45)} T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)(q_{44})^{(9)} G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)} G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION THIRTY FOUR

Alignment Limit In Two-Higgs-Doublet Model

INTRODUCTION—VARIABLES USED

Scrutinizing the Alignment Limit in Two-Higgs-Doublet Models. Part 2: mH=125 GeV Jérémy Bernon, John F. Gunion, Howard E. Haber, Yun Jiang, Sabine Kraml

(1) In the alignment limit of a multi-doublet Higgs sector, one of the Higgs mass eigenstates aligns in (e&eb) field space with (e&eb) the direction of the scalar field vacuum expectation values, and (e&eb) its couplings approach those of (e) the Standard Model (SM) Higgs boson.

(2) Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and (e&eb)Type II near (eb) the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is (=) the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM.

(3) Authors review the theoretical structure and analyze the phenomenological implications of this particular realization of the alignment limit, where (e) decoupling of the extra states cannot (e) occur given that the lighter CP-even state h must, by definition, have (e) a mass below 125 GeV.

(4) For the numerical analysis, we perform scans of the 2HDM parameter space employing (e) the software packages 2HDMC and Lilith, taking into account (e) all relevant pre-LHC constraints, constraints from (e) the measurements of the 125 GeV Higgs signal at (eb) the LHC, as well as the most recent limits coming from (e) searches for heavy Higgs-like states.

(5) Implications for (e&eb) Run 2 at the LHC, including (e) expectations for observing the other scalar states, are also discussed. Subjects: High Energy Physics - Phenomenology (hep-ph) Cite as:

arXiv: 1511.03682 [hep-ph] (or arXiv: 1511.03682v2 [hep-ph] for this version)	
NOTATION	
Module One In the alignment limit of a multi-doublet Higgs sector, one of the Higgs mass eigenstates aligns in field space with (e&eb) the direction of the scalar field vacuum expectation values, and (e&eb) its couplings approach those of (e) the Standard Model (SM) Higgs boson	
G_{13} : Category one of **one of the Higgs mass eigenstates In the alignment limit of a multi-doublet Higgs sector filed space;** direction of the scalar field vacuum expectation values, and (e&eb) its couplings approach those of (e) the Standard Model (SM) Higgs boson G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of direction of the scalar field vacuum expectation values, and (e&eb) its couplings approach those of (e) the Standard Model (SM) Higgs boson **;one of the Higgs mass eigenstates In the alignment limit of a multi-doublet Higgs sector field space;** T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two one of the Higgs mass eigenstates In the alignment limit of a multi-doublet Higgs sector aligns in field space with (e&eb) the direction of the scalar field vacuum expectation values, and (e&eb) its couplings approach those of (e) the Standard Model (SM) Higgs boson	
G_{16} : Category one of **one of the Higgs mass eigenstates In the alignment limit of a multi-doublet Higgs sector aligns in field space;** direction of the scalar field vacuum expectation values, and (e&eb) its couplings approach those of (e) the Standard Model (SM) Higgs boson G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of direction of the scalar field vacuum expectation values, and (e&eb) its couplings approach those of (e) the Standard Model (SM) Higgs boson; **one of the Higgs mass eigenstates In the alignment limit of a multi-doublet Higgs sector aligns in field space** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three one of the Higgs mass eigenstates In the alignment limit of a multi-doublet Higgs sector aligns in field space with the direction of the scalar field vacuum expectation values, and (e&eb) its couplings approach those of (e) the Standard Model (SM) Higgs boson	
G_{20} : Category one of **one of the Higgs mass eigenstates In the alignment limit of a multi-doublet Higgs sector aligns in field space with the direction of the scalar field vacuum expectation values;** its	

couplings approach those of the Standard Model (SM) Higgs boson G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of its couplings approach those of the Standard Model (SM) Higgs boson; **one of the Higgs mass eigenstates In the alignment limit of a multi-doublet Higgs sector aligns in field space with the direction of the scalar field vacuum expectation values** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and (e&eb)Type II near (eb) the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is (=) the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM	
G_{24} : Category one of **CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I;** Type II near (eb) the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is (=) the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one ofType II near (eb) the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is (=) the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM; **CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I** T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near (eb) the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is (=) the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM	
G_{28} : Category one of CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II; alignment limit in which the heavier of the two CP-even Higgs bosons, H, is (=) the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM G_{29} : Category two of SAS	

G_{30} : Category three of SAS	
T_{28} : Category one ofalignment limit in which the heavier of the two CP-even Higgs bosons, H, is (=) the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM; **CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is (=) the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM	
G_{32} : Category one of CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near the alignment limit in which the heavier of the two CP-even Higgs bosons, H G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is the SM-like state observed with (e&eb) a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM	
G_{36} : Category one of **CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is the SM-like state;** mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM; **CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is the SM-like state** T_{37} : Category two of SAS	

T_{38} : Category three of SAS	
Module eight Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is the SM-like state observed with a mass of 125 GeV, and the couplings of H to (e&eb) gauge bosons approach (eb) those of the SM	
G_{40} : Category one of **CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is the SM-like state observed with a mass of 125 GeV, and the couplings of H;** gauge bosons approach those of the SM G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of gauge bosons approach (eb) those of the SM; **CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near the alignment limit in which the heavier of the two CP-even Higgs bosons, H, is the SM-like state observed with a mass of 125 GeV, and the couplings of H** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine Authors review the theoretical structure and analyze the phenomenological implications of this particular realization of the alignment limit, where (e) decoupling of the extra states cannot (e) occur given that the lighter CP-even state h must, by definition, have (e) a mass below 125 GeV	
G_{44} : Category one of occur given that the lighter CP-even state h must, by definition, have (e) a mass below 125 GeV G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of decoupling of the extra states T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$	

$(a_{36})^{(7)},(a_{37})^{(7)},(a_{38})^{(7)},(b_{36})^{(7)},(b_{37})^{(7)},(b_{38})^{(7)}$ $(a_{40})^{(8)},(a_{41})^{(8)},(a_{42})^{(8)},(b_{40})^{(8)},(b_{41})^{(8)},(b_{42})^{(8)}$ $(a_{44})^{(9)},(a_{45})^{(9)},(a_{46})^{(9)},(b_{44})^{(9)},(b_{45})^{(9)},(b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)},(a'_{14})^{(1)},(a'_{15})^{(1)},(b'_{13})^{(1)},(b'_{14})^{(1)},(b'_{15})^{(1)},(a'_{16})^{(2)},(a'_{17})^{(2)},(a'_{18})^{(2)}$, $(b'_{16})^{(2)},(b'_{17})^{(2)},(b'_{18})^{(2)}$ $,(a'_{20})^{(3)},(a'_{21})^{(3)},(a'_{22})^{(3)},(b'_{20})^{(3)},(b'_{21})^{(3)},(b'_{22})^{(3)}$ $(a'_{24})^{(4)},(a'_{25})^{(4)},(a'_{26})^{(4)},(b'_{24})^{(4)},(b'_{25})^{(4)},(b'_{26})^{(4)},(b'_{28})^{(5)},(b'_{29})^{(5)},(b'_{30})^{(5)}$ $(a'_{28})^{(5)},(a'_{29})^{(5)},(a'_{30})^{(5)}$, $(a'_{32})^{(6)},(a'_{33})^{(6)},(a'_{34})^{(6)},(b'_{32})^{(6)},(b'_{33})^{(6)},(b'_{34})^{(6)}$ $(a'_{36})^{(7)},(a'_{37})^{(7)},(a'_{38})^{(7)},(b'_{36})^{(7)},(b'_{37})^{(7)},(b'_{38})^{(7)}$, $(a'_{40})^{(8)},(a'_{41})^{(8)},(a'_{42})^{(8)},(b'_{40})^{(8)},(b'_{41})^{(8)},(b'_{42})^{(8)}$, $(a'_{44})^{(9)},(a'_{45})^{(9)},(a'_{46})^{(9)},(b'_{44})^{(9)},(b'_{45})^{(9)},(b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt}=(a_{13})^{(1)}G_{14}-\left[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt}=(a_{14})^{(1)}G_{13}-\left[(a'_{14})^{(1)}+(a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\left[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\left[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[(b'_{14})^{(1)}-(b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t)=$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t)=$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[(a'_{17})^{(2)}+(a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[(b'_{16})^{(2)}-(b''_{16})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[(b'_{17})^{(2)}-(b''_{17})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[(b'_{18})^{(2)}-(b''_{18})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t)=$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}),t\right)=$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\left[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21},t)\right]G_{20}$	13

$\frac{dG_{21}}{dt}=(a_{21})^{(3)}G_{20}-\left[(a_{21}')^{(3)}+(a_{21}'')^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt}=(a_{22})^{(3)}G_{21}-\left[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt}=(b_{20})^{(3)}T_{21}-\left[(b_{20}')^{(3)}-(b_{20}'')^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt}=(b_{21})^{(3)}T_{20}-\left[(b_{21}')^{(3)}-(b_{21}'')^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt}=(b_{22})^{(3)}T_{21}-\left[(b_{22}')^{(3)}-(b_{22}'')^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}'')^{(3)}(T_{21},t)=$ First augmentation factor	
$-(b_{20}'')^{(3)}(G_{23},t)=$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\left[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\left[(a_{25}')^{(4)}+(a_{25}'')^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\left[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[(b_{24}')^{(4)}-(b_{24}'')^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\left[(b_{25}')^{(4)}-(b_{25}'')^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\left[(b_{26}')^{(4)}-(b_{26}'')^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}'')^{(4)}(T_{25},t)=$ **First augmentation factor**	
$-(b_{24}'')^{(4)}\left((G_{27}),t\right)=$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\left[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\left[(a_{29}')^{(5)}+(a_{29}'')^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt}=(a_{30})^{(5)}G_{29}-\left[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[(b_{28}')^{(5)}-(b_{28}'')^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[(b_{29}')^{(5)}-(b_{29}'')^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[(b_{30}')^{(5)}-(b_{30}'')^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}'')^{(5)}(T_{29},t)=$ **First augmentation factor**	
$-(b_{28}'')^{(5)}\left((G_{31}),t\right)=$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[(a_{32}')^{(6)}+(a_{32}'')^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\left[(a_{33}')^{(6)}+(a_{33}'')^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\left[(a_{34}')^{(6)}+(a_{34}'')^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\left[(b_{32}')^{(6)}-(b_{32}'')^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt}=(b_{33})^{(6)}T_{32}-\left[(b_{33}')^{(6)}-(b_{33}'')^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35

$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} \left((G_{35}), t \right) \right] T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)} (T_{37}, t) \right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} (T_{37}, t) \right] G_{37}$	38
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} (T_{37}, t) \right] G_{38}$	39
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} \left((G_{39}), t \right) \right] T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} \left((G_{39}), t \right) \right] T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} \left((G_{39}), t \right) \right] T_{38}$	42
$+(a_{36}^{''})^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)} (T_{41}, t) \right] G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}, t) \right] G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}, t) \right] G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} \left((G_{43}), t \right) \right] T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} \left((G_{43}), t \right) \right] T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} \left((G_{43}), t \right) \right] T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)} (T_{45}, t) \right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)} (T_{45}, t) \right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}, t) \right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)} \left((G_{47}), t \right) \right] T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}\left((G_{47}), t \right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[\begin{matrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14}, t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17}, t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21}, t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25}, t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29}, t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33}, t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37}, t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41}, t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45}, t)} \end{matrix} \right] G_{13}$	55

$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	58
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	59
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	60
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for	

category 1, 2 and 3 $-(b''_{20})^{(3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,)}(G_{23},t)$ are third detrition coefficients for category 1, 2 and 3 $-(b''_{24})^{(4,4,4,4,)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,)}(G_{27},t)$ are fourth detrition coefficients for category 1, 2 and 3 $-(b''_{28})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,)}(G_{31},t)$ are fifth detrition coefficients for category 1, 2 and 3 $-(b''_{32})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,)}(G_{35},t)$ are sixth detrition coefficients for category 1, 2 and 3 $-(b''_{37})^{(7,7,)}(G_{39},t)$, $-(b''_{36})^{(7,7,)}(G_{39},t)$, $-(b''_{38})^{(7,7,)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b''_{40})^{(8,8)}(G_{43},t)$ $-(b''_{41})^{(8,8)}(G_{43},t)$ $-(b''_{42})^{(8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3 $-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \begin{bmatrix} (a'_{16})^{(2)} +(a''_{16})^{(2)}(T_{17},t) +(a''_{13})^{(1,1,)}(T_{14},t) +(a''_{20})^{(3,3,3)}(T_{21},t) \\ +(a''_{24})^{(4,4,4,4,4)}(T_{25},t) +(a''_{28})^{(5,5,5,5,5)}(T_{29},t) +(a''_{32})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{36})^{(7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8)}(T_{41},t) +(a''_{44})^{(9,9)}(T_{45},t) \end{bmatrix} G_{16}$	61
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \begin{bmatrix} (a'_{17})^{(2)} +(a''_{17})^{(2)}(T_{17},t) +(a''_{14})^{(1,1,)}(T_{14},t) +(a''_{21})^{(3,3,3)}(T_{21},t) \\ +(a''_{25})^{(4,4,4,4,4)}(T_{25},t) +(a''_{29})^{(5,5,5,5,5)}(T_{29},t) +(a''_{33})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{37})^{(7,7,7)}(T_{37},t) +(a''_{41})^{(8,8,8)}(T_{41},t) +(a''_{45})^{(9,9)}(T_{45},t) \end{bmatrix} G_{17}$	62
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \begin{bmatrix} (a'_{18})^{(2)} +(a''_{18})^{(2)}(T_{17},t) +(a''_{15})^{(1,1,)}(T_{14},t) +(a''_{22})^{(3,3,3)}(T_{21},t) \\ +(a''_{26})^{(4,4,4,4,4)}(T_{25},t) +(a''_{30})^{(5,5,5,5,5)}(T_{29},t) +(a''_{34})^{(6,6,6,6,6)}(T_{33},t) \\ +(a''_{38})^{(7,7,7)}(T_{37},t) +(a''_{42})^{(8,8,8)}(T_{41},t) +(a''_{46})^{(9,9)}(T_{45},t) \end{bmatrix} G_{18}$	63
Where $+(a''_{16})^{(2)}(T_{17},t)$, $+(a''_{17})^{(2)}(T_{17},t)$, $+(a''_{18})^{(2)}(T_{17},t)$ are first augmentation coefficients for category 1, 2 and 3 $+(a''_{13})^{(1,1,)}(T_{14},t)$, $+(a''_{14})^{(1,1,)}(T_{14},t)$, $+(a''_{15})^{(1,1,)}(T_{14},t)$ are second augmentation coefficient for category 1, 2 and 3 $+(a''_{20})^{(3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3)}(T_{21},t)$ are third augmentation coefficient for category 1, 2 and 3 $+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)$, $+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficient for category 1, 2 and 3 $+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)$, $+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficient for category 1, 2 and 3 $+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficient for category 1, 2 and 3	

$+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3 $+(a''_{44})^{(9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9)}(T_{45},t)$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} -(b''_{16})^{(2)}(G_{19},t) -(b''_{13})^{(1,1,)}(G,t) -(b''_{20})^{(3,3,3,)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8)}(G_{43},t) -(b''_{44})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{16}$	*64*
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} -(b''_{17})^{(2)}(G_{19},t) -(b''_{14})^{(1,1,)}(G,t) -(b''_{21})^{(3,3,3,)}(G_{23},t) \\ -(b''_{25})^{(4,4,4,4,4)}(G_{27},t) -(b''_{29})^{(5,5,5,5,5)}(G_{31},t) -(b''_{33})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{37})^{(7,7,7)}(G_{39},t) -(b''_{41})^{(8,8,8)}(G_{43},t) -(b''_{45})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{17}$	*65*
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} -(b''_{18})^{(2)}(G_{19},t) -(b''_{15})^{(1,1,)}(G,t) -(b''_{22})^{(3,3,3,)}(G_{23},t) \\ -(b''_{26})^{(4,4,4,4,4)}(G_{27},t) -(b''_{30})^{(5,5,5,5,5)}(G_{31},t) -(b''_{34})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{38})^{(7,7,7)}(G_{39},t) -(b''_{42})^{(8,8,8)}(G_{43},t) -(b''_{46})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{18}$	*66*
where $-(b''_{16})^{(2)}(G_{19},t)$, $-(b''_{17})^{(2)}(G_{19},t)$, $-(b''_{18})^{(2)}(G_{19},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{13})^{(1,1,)}(G,t)$, $-(b''_{14})^{(1,1,)}(G,t)$, $-(b''_{15})^{(1,1,)}(G,t)$ are second detrition coefficients for category 1,2 and 3 $-(b''_{20})^{(3,3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,)}(G_{23},t)$ are third detrition coefficients for category 1,2 and 3 $-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1,2 and 3 $-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1,2 and 3 $-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1,2 and 3 $-(b''_{36})^{(7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3 $-(b''_{40})^{(8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3 $-(b''_{44})^{(9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} +(a''_{20})^{(3)}(T_{21},t) +(a''_{16})^{(2,2,2)}(T_{17},t) +(a''_{13})^{(1,1,1,)}(T_{14},t) \\ +(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t) +(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t) +(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{36})^{(7,7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8,8)}(T_{41},t) +(a''_{44})^{(9,9,9)}(T_{45},t) \end{matrix} \right] G_{20}$	*67*

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21} \quad 68$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22} \quad 69$$

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{20} \quad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21} \quad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22} \quad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for*

category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1, 2\ \ 3$

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ $are\ second\ augmentation\ coefficient\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ $are\ fourth\ augmentation\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ $are\ fifth\ augmentation\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ $are\ sixth\ augmentation\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$

are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$

are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b'_{26})^{(4)}\boxed{-(b''_{26})^{(4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)}\boxed{+(a''_{28})^{(5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28} \quad 79$$

$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \left[\begin{matrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \left[\begin{matrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{30}$	81
Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \left[\begin{matrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{30}$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients*	

for category 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{32}$	*85*
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{33}$	*86*
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{34}$	*87*
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients	

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32}$	88
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$	89
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad (91)$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14} \quad (92)$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \quad (93)$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \quad (94)$$

$$\frac{dT_{37}}{dt} =$$

$$(b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)}\boxed{-(b''_{37})^{(7)}(G_{39},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} =$$

$$(b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)}\boxed{-(b''_{38})^{(7)}(G_{39},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 95

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a_{41}')^{(8)} \boxed{+(a_{41}'')^{(8)}(T_{41},t)} \boxed{+(a_{17}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a_{42}')^{(8)} \boxed{+(a_{42}'')^{(8)}(T_{41},t)} \boxed{+(a_{18}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a_{40}'')^{(8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{13}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a_{14}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a_{15}'')^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a_{36}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a_{46}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b_{40}')^{(8)} \boxed{-(b_{40}'')^{(8)}(G_{43},t)} \boxed{-(b_{16}'')^{(2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{24}'')^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b_{36}'')^{(7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{41}}{dt} =$$

$(b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)} \boxed{-(b''_{41})^{(8)}(G_{43},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$	
$\frac{dT_{42}}{dt} =$ $(b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)} \boxed{-(b''_{42})^{(8)}(G_{43},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{13}$	*96*
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix} \right] G_{14}$	

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)}\boxed{+(a''_{46})^{(9)}(T_{37},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)}\boxed{-(b''_{44})^{(9)}(G_{47},t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \begin{bmatrix} (b'_{45})^{(9)}\boxed{-(b''_{45})^{(9)}(G_{47},t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45} - \begin{bmatrix} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \le (p_i)^{(1)} \le (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \le (r_i)^{(1)} \le (b'_i)^{(1)} \le (\hat{B}_{13})^{(1)}$	97
$lim_{T_2\to\infty}(a''_i)^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G\to\infty}(b''_i)^{(1)}(G,t) = (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\lvert(a_i^{''})^{(1)}(T_{14}^{'},t)-(a_i^{''})^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}^{'}\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i^{''})^{(1)}(G^{'},t)-(b_i^{''})^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G-G^{'}\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(1)}(T_{14}^{'},t)$ and $(a_i^{''})^{(1)}(T_{14},t)$. $(T_{14}^{'},t)$ and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i^{''})^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i^{''})^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\ ,\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i^{'})^{(1)},(b_i)^{(1)},(b_i^{'})^{(1)},(p_i)^{(1)},\ (r_i)^{(1)},i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[\,(a_i)^{(1)}+(a_i^{'})^{(1)}+\ (\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}\,(\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[\,(b_i)^{(1)}+(b_i^{'})^{(1)}+\ (\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}\ (\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i^{'})^{(2)},(a_i^{''})^{(2)},(b_i)^{(2)},(b_i^{'})^{(2)},(b_i^{''})^{(2)}>0,\quad i,j=16,17,18$	
The functions $(a_i^{''})^{(2)},(b_i^{''})^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)},\ (r_i)^{(2)}$:	
$(a_i^{''})^{(2)}(T_{17},t)\leq(p_i)^{(2)}\leq\left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19},t)\leq\ (r_i)^{(2)}\leq(b_i^{'})^{(2)}\leq(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i^{''})^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i^{''})^{(2)}\left((G_{19}),t\right)=\ (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	

$\lvert(a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\rvert \le (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19})-(G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}$, $\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\,(a_i)^{(2)}+(a_i')^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i')^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)},\ (\mathrm{r}_i)^{(3)}$: $(a_i'')^{(3)}(T_{21},t)\le(p_i)^{(3)}\le(\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t)\le\ (r_i)^{(3)}\le(b_i')^{(3)}\le(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}(T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}(G_{23},t)=\ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $\boxed{(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}}$ are positive constants and $\boxed{i=20,21,22}$	113

They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21}-T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}',t)-(b_i'')^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23}-G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and $(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}$, $\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)}, (r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)}+(a_i')^{(3)}+(\hat{A}_{20})^{(3)}+(\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)}+(b_i')^{(3)}+(\hat{B}_{20})^{(3)}+(\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}]<1$	116
Where we suppose	
$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)}>0, \quad i,j=24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t)=(r_i)^{(4)}$ <u>**Definition of**</u> $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)}, (r_i)^{(4)}$ are positive constants and $i=24,25,26$	118
They satisfy Lipschitz condition:	119

$\lvert(a_i'')^{(4)}(T_{25}',t)-(a_i'')^{(4)}(T_{25},t)\rvert \leq (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i'')^{(4)}((G_{27})',t)-(b_i'')^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and$(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
<u>Definition of</u> $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(p_i)^{(4)},\ (r_i)^{(4)},i=24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\,(a_i)^{(4)}+(a_i')^{(4)}+\ (\hat{A}_{24})^{(4)}+\ (\hat{P}_{24})^{(4)}\,(\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)}+(b_i')^{(4)}+\ (\hat{B}_{24})^{(4)}+\ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i')^{(5)},(a_i'')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(b_i'')^{(5)}>0,\quad i,j=28,29,30$ The functions $(a_i'')^{(5)},(b_i'')^{(5)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(5)},\ \ (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t)\leq(p_i)^{(5)}\leq(\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}),t)\leq\ (r_i)^{(5)}\leq(b_i')^{(5)}\leq(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t)=\ (r_i)^{(5)}$ **<u>Definition of</u>** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123

They satisfy Lipschitz condition: $\|(a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\| \leq (\hat{k}_{28})^{(5)}\|T_{29}-T_{29}'\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}((G_{31}),t)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31})-(G_{31})'\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
<u>Definition of</u> $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and\ (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(p_i)^{(5)},\ (r_i)^{(5)},i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)}+(a_i')^{(5)}+(\hat{A}_{28})^{(5)}+(\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)}+(b_i')^{(5)}+(\hat{B}_{28})^{(5)}+(\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i')^{(6)},(a_i'')^{(6)},(b_i)^{(6)},(b_i')^{(6)},(b_i'')^{(6)}>0,\quad i,j=32,33,34$ The functions $(a_i'')^{(6)},(b_i'')^{(6)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(6)},\ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t)\leq(p_i)^{(6)}\leq(\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t)\leq\ (r_i)^{(6)}\leq(b_i')^{(6)}\leq(\hat{B}_{32})^{(6)}$	127
$lim_{T_2\to\infty}(a_i'')^{(6)}(T_{33},t)=(p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}((G_{35}),t)=\ (r_i)^{(6)}$ **<u>Definition of</u>** $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$:	128

Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	
They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(6)}(T_{33}^{'},t) - (a_i^{''})^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)} \lvert T_{33} - T_{33}^{'} \rvert e^{-(\hat{M}_{32})^{(6)} t}$ $\lvert (b_i^{''})^{(6)}((G_{35})^{'},t) - (b_i^{''})^{(6)}((G_{35}),t)\rvert < (\hat{k}_{32})^{(6)} \lvert\lvert (G_{35}) - (G_{35})^{'} \rvert\rvert e^{-(\hat{M}_{32})^{(6)} t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}^{'},t)$ and $(a_i^{''})^{(6)}(T_{33},t)$. $(T_{33}^{'},t)$ and (T_{33},t) are points belonging to the interval $\left[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\right]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i^{''})^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>Definition of</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i^{'})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}} [\ (a_i)^{(6)} + (a_i^{'})^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}} [\ (b_i)^{(6)} + (b_i^{'})^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)} \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(WWWWWWWW) $\quad (a_i)^{(7)}, (a_i^{'})^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (b_i^{''})^{(7)} > 0, \quad i,j = 36,37,38$ (XXXXXXXX) The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i^{''})^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i^{''})^{(7)}(G_{39},t) \leq \ (r_i)^{(7)} \leq (b_i^{'})^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
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Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}$ are positive constants and $i = 36,37,38$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}', t) - (a_i'')^{(7)}(T_{37}, t)\rvert \leq (\hat{k}_{36})^{(7)} \lvert T_{37} - T_{37}' \rvert e^{-(\hat{M}_{36})^{(7)} t}$ $\lvert(b_i'')^{(7)}((G_{39})', t) - (b_i'')^{(7)}((G_{39}), t)\rvert < (\hat{k}_{36})^{(7)} \lvert\lvert (G_{39}) - (G_{39})' \rvert\rvert e^{-(\hat{M}_{36})^{(7)} t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}', t)$ and $(a_i'')^{(7)}(T_{37}, t)$. (T_{37}', t) and (T_{37}, t) are points belonging to the interval $[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}]$. It is to be noted that $(a_i'')^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (AAAAAAAAA) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (BBBBBBBBB) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)} (\hat{k}_{36})^{(7)}] < 1$	135
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$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i, j = 40,41,42$	136
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Definition of $(p_i)^{(8)}, (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$	138

$(b_i'')^{(8)}((G_{43}),t) \leq \ (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty}(a_i'')^{(8)}(T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty}(b_i'')^{(8)}\left((G_{43}),t\right) = \ (r_i)^{(8)}$	141
Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)},\ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\|(a_i'')^{(8)}(T_{41}',t) - (a_i'')^{(8)}(T_{41},t)\| \leq (\hat{k}_{40})^{(8)}\|T_{41} - T_{41}'\|e^{-(\hat{M}_{40})^{(8)}t}$	142
$\|(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}\left((G_{43}),t\right)\| < (\hat{k}_{40})^{(8)}\|\|(G_{43}) - (G_{43})'\|\|e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\ ,\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
Definition of $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)},\ (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
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Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i'')^{(9)}, (b_i'')^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$$(a_i'')^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$$

$$(b_i'')^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i')^{(9)} \leq (\hat{B}_{44})^{(9)}$$

$$\lim_{T_2\to\infty} (a_i'')^{(9)}(T_{45},t) = (p_i)^{(9)}$$

$$\lim_{G\to\infty} (b_i'')^{(9)}(G_{47},t) = (r_i)^{(9)}$$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$$|(a_i'')^{(9)}(T_{45}',t) - (a_i'')^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}'|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i'')^{(9)}((G_{47})',t) - (b_i'')^{(9)}\big((G_{47}),t\big)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})'||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $\big[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\big]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)} + (a_i')^{(9)} + \ (\hat{A}_{44})^{(9)} + \ (\hat{P}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)} + (b_i')^{(9)} + \ (\hat{B}_{44})^{(9)} + \ (\hat{Q}_{44})^{(9)}\ \ (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13}\right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)}t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$:	153

$G_i(t) \leq \left(\hat{P}_{36} \right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40} \right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)$, $T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44} \right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{13}(s_{(13)}) \right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \right) G_{15}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{13}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{14}(s_{(13)}) \right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)} (G(s_{(13)}), s_{(13)}) \right) T_{15}(s_{(13)}) \right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i\,,\, T_i \colon \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \leq (\,\hat{P}_{16}\,)^{(2)}\,, T_i^0 \leq (\,\hat{Q}_{16}\,)^{(2)},$	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)} \left(T_{17}\left(s_{(16)}\right), s_{(16)} \right) \right) G_{16}\left(s_{(16)}\right) \right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}\left(s_{(16)}\right) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)} \left(T_{17}\left(s_{(16)}\right), s_{(17)} \right) \right) G_{17}\left(s_{(16)}\right) \right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}\left(s_{(16)}\right) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)} \left(T_{17}\left(s_{(16)}\right), s_{(16)} \right) \right) G_{18}\left(s_{(16)}\right) \right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)} \left(G_{19}\left(s_{(16)}\right), s_{(16)} \right) \right) T_{16}\left(s_{(16)}\right) \right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}\left(s_{(16)}\right) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)} \left(G_{19}\left(s_{(16)}\right), s_{(16)} \right) \right) T_{17}\left(s_{(16)}\right) \right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}\left(s_{(16)}\right) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)} \left(G_{19}\left(s_{(16)}\right), s_{(16)} \right) \right) T_{18}\left(s_{(16)}\right) \right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i\,,\, T_i \colon \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \leq (\,\hat{P}_{20}\,)^{(3)}\,, T_i^0 \leq (\,\hat{Q}_{20}\,)^{(3)},$	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)} \left(T_{21}\left(s_{(20)}\right), s_{(20)} \right) \right) G_{20}\left(s_{(20)}\right) \right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}\left(s_{(20)}\right) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)} \left(T_{21}\left(s_{(20)}\right), s_{(20)} \right) \right) G_{21}\left(s_{(20)}\right) \right] ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{32})^{(6)}$, $T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \rightarrow \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{36})^{(7)}$, $T_i^0 \leq (\hat{Q}_{36})^{(7)}$,

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$

By 165

$$\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$$

$$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$$

$$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$$

$$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$$

$$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$$

$$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$$

Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$

Proof:

Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{40})^{(8)}$, $T_i^0 \leq (\hat{Q}_{40})^{(8)}$,

$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$

$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$

By 166

$$\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$$

$$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$$

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{44})^{(9)}$,$T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that	168

$(G_{13}(t)-G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)}+G_{14}^0\right)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)}+(\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0+\int_0^t\left[(a_{16})^{(2)}\left(G_{17}^0+(\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right]ds_{(16)}=$ $\left(1+(a_{16})^{(2)}t\right)G_{17}^0+\frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t}-1\right)$	169
From which it follows that $(G_{16}(t)-G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)}+G_{17}^0\right)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)}+(\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0+\int_0^t\left[(a_{20})^{(3)}\left(G_{21}^0+(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right]ds_{(20)}=$ $\left(1+(a_{20})^{(3)}t\right)G_{21}^0+\frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t}-1\right)$	171
From which it follows that $(G_{20}(t)-G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{P}_{20})^{(3)}+G_{21}^0\right)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)}+(\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0+\int_0^t\left[(a_{24})^{(4)}\left(G_{25}^0+(\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right]ds_{(24)}=$ $\left(1+(a_{24})^{(4)}t\right)G_{25}^0+\frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t}-1\right)$	173
From which it follows that $(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176
From which it follows that $(G_{32}(t) - G_{32}^0) e^{-(\hat{M}_{32})^{(6)} t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left[\left((\hat{P}_{32})^{(6)} + G_{33}^0 \right) e^{\left(-\frac{(\hat{P}_{32})^{(6)} + G_{33}^0}{G_{33}^0} \right)} + (\hat{P}_{32})^{(6)} \right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(ii) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} \left(G_{37}^0 + (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} s_{(36)}} \right) \right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)} t\right) G_{37}^0 + \frac{(a_{36})^{(7)} (\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left(e^{(\hat{M}_{36})^{(7)} t} - 1 \right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0) e^{-(\hat{M}_{36})^{(7)} t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left[\left((\hat{P}_{36})^{(7)} + G_{37}^0 \right) e^{\left(-\frac{(\hat{P}_{36})^{(7)} + G_{37}^0}{G_{37}^0} \right)} + (\hat{P}_{36})^{(7)} \right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}} \right) \right] ds_{(40)} =$	180

$\left(1+(a_{40})^{(8)}t\right)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41}, $G_{42}, T_{40}, T_{41}, T_{42}$	181
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In the same way , one can obtain

$$G_{18} \leq \left((\widehat{M}_{16})^{(2)} \right)_3 = G_{18}^0 + 2(a_{18})^{(2)} \left((\widehat{M}_{16})^{(2)} \right)_2 / (a_{18}')^{(2)}$$

If G_{17} or G_{18} is bounded, the same property follows for G_{16} , G_{18} and G_{16} , G_{17} respectively.

Remark 9: If G_{16} is bounded, from below, the same property holds for G_{17} and G_{18} . The proof is analogous with the preceding one. An analogous property is true if G_{17} is bounded from below. 202

Remark 10: If T_{16} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(2)}((G_{19})(t),t)) = (b_{17}')^{(2)}$ then $T_{17} \to \infty$. 203

Definition of $(m)^{(2)}$ and ε_2 :

Indeed let t_2 be so that for $t > t_2$

$$(b_{17})^{(2)} - (b_i'')^{(2)}((G_{19})(t),t) < \varepsilon_2, T_{16}(t) > (m)^{(2)}$$

Then $\frac{dT_{17}}{dt} \geq (a_{17})^{(2)}(m)^{(2)} - \varepsilon_2 T_{17}$ which leads to 204

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$T_{17} \geq \left(\frac{(a_{17})^{(2)}(m)^{(2)}}{2} \right), \quad t = \log \frac{2}{\varepsilon_2}$ By taking now ε_2 sufficiently small one sees that T_{17} is unbounded. The same property holds for T_{18} if $\lim_{t\to\infty}(b_{18}'')^{(2)}\left((G_{19})(t),t\right) = (b_{18}')^{(2)}$ 205

We now state a more precise theorem about the behaviors at infinity of the solutions of equations

It is now sufficient to take $\frac{(a_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}} < 1$ and to choose 207

$(\widehat{P}_{20})^{(3)}$ and $(\widehat{Q}_{20})^{(3)}$ large to have

$$\frac{(a_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}} \left[(\widehat{P}_{20})^{(3)} + ((\widehat{P}_{20})^{(3)} + G_j^0) e^{-\left(\frac{(\widehat{P}_{20})^{(3)} + G_j^0}{G_j^0} \right)} \right] \leq (\widehat{P}_{20})^{(3)}$$ 208

$$\frac{(b_i)^{(3)}}{(\mathcal{M}_{20})^{(3)}} \left[((\widehat{Q}_{20})^{(3)} + T_j^0) e^{-\left(\frac{(\widehat{Q}_{20})^{(3)} + T_j^0}{T_j^0} \right)} + (\widehat{Q}_{20})^{(3)} \right] \leq (\widehat{Q}_{20})^{(3)}$$ 209

In order that the operator $\mathcal{A}^{(3)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself 210

The operator $\mathcal{A}^{(3)}$ is a contraction with respect to the metric 211

$$d\left(((G_{23})^{(1)}, (T_{23})^{(1)}), ((G_{23})^{(2)}, (T_{23})^{(2)}) \right) =$$

$$\sup_i \{ \max_{t\in\mathbb{R}_+} |G_i^{(1)}(t) - G_i^{(2)}(t)| e^{-(\mathcal{M}_{20})^{(3)} t}, \max_{t\in\mathbb{R}_+} |T_i^{(1)}(t) - T_i^{(2)}(t)| e^{-(\mathcal{M}_{20})^{(3)} t} \}$$

Indeed if we denote **Definition of** $\widetilde{G_{23}}, \widetilde{T_{23}}$: $\left(\widetilde{(G_{23})}, \widetilde{(T_{23})} \right) = \mathcal{A}^{(3)}\left((G_{23}),(T_{23})\right)$	212
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In the same way , one can obtain $G_{22} \leq \left((\widehat{M}_{20})^{(3)} \right)_3 = G_{22}^0 + 2(a_{22})^{(3)} \left((\widehat{M}_{20})^{(3)} \right)_2 / (a_{22}')^{(3)}$ If G_{21} *or* G_{22} is bounded, the same property follows for G_{20} , G_{22} and G_{20} , G_{21} respectively.	
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Indeed if we denote

<u>Definition of</u> $\widetilde{(G_{27})}, \widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})}, \widetilde{(T_{27})} \right) = \mathcal{A}^{(4)}((G_{27}), (T_{27}))$

It results

$$\left|\tilde{G}_{24}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{24})^{(4)} \left|G_{25}^{(1)} - G_{25}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \, ds_{(24)} +$$

$$\int_0^t \{(a_{24}^{'})^{(4)} \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$(a_{24}^{''})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right) \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$G_{24}^{(2)} |(a_{24}^{''})^{(4)}\left(T_{25}^{(1)}, s_{(24)}\right) - (a_{24}^{''})^{(4)}\left(T_{25}^{(2)}, s_{(24)}\right)| \; e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \} ds_{(24)}$$

Where $s_{(24)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on Equations it follows

$$\left|(G_{27})^{(1)} - (G_{27})^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} t} \leq$$
$$\frac{1}{(\widehat{M}_{24})^{(4)}} \left((a_{24})^{(4)} + (a_{24}^{'})^{(4)} + (\widehat{A}_{24})^{(4)} + (\widehat{P}_{24})^{(4)} (\widehat{k}_{24})^{(4)} \right) d\left(\left((G_{27})^{(1)}, (T_{27})^{(1)};\; (G_{27})^{(2)}, (T_{27})^{(2)} \right) \right)$$ 226

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

<u>Remark 16:</u> The fact that we supposed $(a_{24}^{''})^{(4)}$ and $(b_{24}^{''})^{(4)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ *and* $(\widehat{Q}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ respectively of $\mathbb{R}_+$. 227

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(4)}$ and $(b_i^{''})^{(4)}, i = 24,25,26$ depend only on T_{25} and respectively on $(G_{27})(\textit{and not on } t)$ and hypothesis can replaced by a usual Lipschitz condition.

<u>Remark 17:</u> There does not exist any t where $G_i\,(t) = 0$ *and* $T_i\,(t) = 0$ 228

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$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(4)} - (a_i^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\} ds_{(24)} \right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(4)} t\right)} > 0 \quad \text{for } \mathrm{t} > 0$$

<u>Definition of</u> $\left((\widehat{M}_{24})^{(4)}\right)_1, \left((\widehat{M}_{24})^{(4)}\right)_2$ *and* $\left((\widehat{M}_{24})^{(4)}\right)_3$: 229

<u>Remark 18:</u> if G_{24} is bounded, the same property have also G_{25} *and* G_{26} . indeed if

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$$G_{25} \leq \left((\widehat{M}_{24})^{(4)}\right)_2 = G_{25}^0 + 2(a_{25})^{(4)} \left((\widehat{M}_{24})^{(4)}\right)_1 / (a_{25}^{'})^{(4)}$$

In the same way , one can obtain $G_{26} \leq \left((\widehat{M}_{24})^{(4)} \right)_3 = G_{26}^0 + 2(a_{26})^{(4)} \left((\widehat{M}_{24})^{(4)} \right)_2 / (a_{26}^{'})^{(4)}$ If G_{25} *or* G_{26} is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.	
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$\frac{(a_i)^{(8)}}{(\widehat{M}_{40})^{(8)}}\left[(\widehat{P}_{40})^{(8)} + \left((\widehat{P}_{40})^{(8)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{40})^{(8)} + G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{40})^{(8)}$	267
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{40})^{(8)}t}\}$	269
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$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)}+((\hat{P}_{44})^{(9)}+G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{44})^{(9)}\right]\leq(\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right)=$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}|G_i^{(1)}(t)-G_i^{(2)}(t)|e^{-(\hat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}|T_i^{(1)}(t)-T_i^{(2)}(t)|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})},\widetilde{(T_{47})}:(\widetilde{(G_{47})},\widetilde{(T_{47})})=\mathcal{A}^{(9)}((G_{47}),(T_{47}))$
It results

$$|\tilde{G}_{44}^{(1)}-\tilde{G}_i^{(2)}|\leq\int_0^t(a_{44})^{(9)}|G_{45}^{(1)}-G_{45}^{(2)}|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}ds_{(44)}+$$
$$\int_0^t\{(a'_{44})^{(9)}|G_{44}^{(1)}-G_{44}^{(2)}|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}}+$$
$$(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})|G_{44}^{(1)}-G_{44}^{(2)}|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}+$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})-(a''_{44})^{(9)}(T_{45}^{(2)},s_{(44)})|\ e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)}-G^{(2)}|e^{-(\hat{M}_{44})^{(9)}t}\leq$$
$$\frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)}+(a'_{44})^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ *and* $(\hat{Q}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i=44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$

From 99 to 44 it results

$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i\,(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}\left((G_{47})(t), t\right)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i'')^{(9)}\left((G_{47})(t), t\right) < \varepsilon_9, T_{44}\,(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}\left((G_{47})(t), t\right) = (b_{46}')^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14}, t) + (a_{14}'')^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G,t) - (b''_{14})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}, if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$ and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a'_{15})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}\right] + G_{15}^0 e^{-(a'_{15})^{(1)}t})$	286

$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b_{15}')^{(1)}t}\right] + T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a_{13}')^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b_{13}')^{(1)}$ $(R_2)^{(1)} = (b_{15}')^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}\big((G_{19}), t\big) - (b_{17}'')^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \ \boldsymbol{if} \ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if} \ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \ \boldsymbol{if} \ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if} \ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}, \ \boldsymbol{if} \ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq \right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}\right] + G_{18}^0 e^{-(a_{18}')^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t}\right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}^{'})^{(2)}$ $(R_2)^{(2)} = (b_{18}^{'})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} - (a_{20}^{''})^{(3)}(T_{21}, t) + (a_{21}^{''})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}, t) - (b_{21}^{''})^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},$ ***if*** $(\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},$ ***if*** $(\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},$ ***if*** $(\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},$ ***if*** $(u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},$ ***if*** $(u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}, \ \textbf{\textit{if}}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)}G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)}G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a'_{22})^{(3)})}[e^{(S_1)^{(3)}t} - e^{-(a'_{22})^{(3)}t}] + G_{22}^0 e^{-(a'_{22})^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)}T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b'_{22})^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b'_{22})^{(3)}t}\right] + T_{22}^0 e^{-(b'_{22})^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)}T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a'_{20})^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b'_{20})^{(3)}$ $(R_2)^{(3)} = (b'_{22})^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a'_{24})^{(4)} + (a'_{25})^{(4)} - (a''_{24})^{(4)}(T_{25}, t) + (a''_{25})^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b'_{24})^{(4)} + (b'_{25})^{(4)} - (b''_{24})^{(4)}\left((G_{27}), t\right) - (b''_{25})^{(4)}\left((G_{27}), t\right) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations	329

$(a_{25})^{(4)}\left(v^{(4)}\right)^2+(\sigma_1)^{(4)}v^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	
Definition of $(\bar{v}_1)^{(4)},,(\bar{v}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{v}_1)^{(4)}>0\,,(\bar{v}_2)^{(4)}<0$ and respectively $(\bar{u}_1)^{(4)}>0\,,(\bar{u}_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(v^{(4)}\right)^2+(\sigma_2)^{(4)}v^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)}\,,(m_2)^{(4)}\,,(\mu_1)^{(4)},(\mu_2)^{(4)},(v_0)^{(4)}$:- If we define $(m_1)^{(4)}\,,(m_2)^{(4)}\,,(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(v_0)^{(4)},(m_1)^{(4)}=(v_1)^{(4)},\ \boldsymbol{if}\ (v_0)^{(4)}<(v_1)^{(4)}$ $(m_2)^{(4)}=(v_1)^{(4)},(m_1)^{(4)}=(\bar{v}_1)^{(4)}\,,\boldsymbol{if}\ (v_4)^{(4)}<(v_0)^{(4)}<(\bar{v}_1)^{(4)}$, and $\boxed{(v_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(v_4)^{(4)},(m_1)^{(4)}=(v_0)^{(4)},\ \boldsymbol{if}\ (\bar{v}_4)^{(4)}<(v_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar{u}_1)^{(4)}\,,\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)}=\frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(u_0)^{(4)},\boldsymbol{if}\ (\bar{u}_1)^{(4)}<(u_0)^{(4)}$ where $(u_1)^{(4)},(\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0e^{((S_1)^{(4)}-(p_{24})^{(4)})t}\leq G_{24}(t)\leq G_{24}^0e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}}G_{24}^0e^{((S_1)^{(4)}-(p_{24})^{(4)})t}\leq G_{25}(t)\leq\frac{1}{(m_2)^{(4)}}G_{24}^0e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t}-e^{-(S_2)^{(4)}t}\right]+G_{26}^0e^{-(S_2)^{(4)}t}\leq G_{26}(t)\leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq T_{24}^0e^{((R_1)^{(4)}+(r_{24})^{(4)})t}}$	
$\frac{1}{(\mu_1)^{(4)}}T_{24}^0e^{(R_1)^{(4)}t}\leq T_{24}(t)\leq\frac{1}{(\mu_2)^{(4)}}T_{24}^0e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t}-e^{-(b_{26}')^{(4)}t}\right]+T_{26}^0e^{-(b_{26}')^{(4)}t}\leq T_{26}(t)\leq$	336

$\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: By $(\nu_1)^{(5)} > 0, (\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0, (u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}(\nu^{(5)})^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}(u^{(5)})^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0, (\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0, (\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}(\nu^{(5)})^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}(u^{(5)})^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)},$ ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},$ ***if*** $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}$, ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}$, ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)}-(p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)}-(p_{28})^{(5)}-(S_2)^{(5)})}\left[e^{((S_1)^{(5)}-(p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)}+(r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b'_{30})^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b'_{30})^{(5)}t}\right] + T_{30}^0 e^{-(b'_{30})^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
<u>**Definition of**</u> $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a'_{28})^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b'_{28})^{(5)}$ $(R_2)^{(5)} = (b'_{30})^{(5)} - (r_{30})^{(5)}$	348
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33}, t) + (a''_{33})^{(6)}(T_{33}, t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}), t\big) - (b''_{33})^{(6)}\big((G_{35}), t\big) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}, (m_2)^{(6)}, (\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)},\ \boldsymbol{if}\ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)},$ and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)},\ \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)}G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^{0} e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^{0} e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^{0} e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^{0} e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^{0}}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^{0} e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^{0}}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^{0} e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by	362

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)} t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)} t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)} t}\right] + G_{38}^0 e^{-(S_2)^{(7)} t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})}\left[e^{(S_1)^{(7)} t} - e^{-(a_{38}')^{(7)} t}\right] + G_{38}^0 e^{-(a_{38}')^{(7)} t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})}\left[e^{(R_1)^{(7)} t} - e^{-(b_{38}')^{(7)} t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)} t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)} + (r_{36})^{(7)} + (R_2)^{(7)})}\left[e^{((R_1)^{(7)} + (r_{36})^{(7)})t} - e^{-(R_2)^{(7)} t}\right] + T_{38}^0 e^{-(R_2)^{(7)} t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)} (m_2)^{(7)} - (a_{36}')^{(7)}$	370

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$ $(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$	
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}((G_{43}), t) - (b''_{41})^{(8)}((G_{43}), t) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
Definition of $(\bar{\nu}_1)^{(8)}, , (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}, \; \boldsymbol{if} \; (\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}, \boldsymbol{if} \; (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $(\nu_0)^{(8)} = \frac{G^0_{40}}{G^0_{41}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}, \ \boldsymbol{if} \ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)} \ , \boldsymbol{if} \ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if} \ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)} t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)} t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)})}\left[e^{((S_1)^{(8)} - (p_{40})^{(8)})t} - e^{-(S_2)^{(8)} t}\right] + G_{42}^0 e^{-(S_2)^{(8)} t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)} - (a'_{42})^{(8)})}[e^{(S_1)^{(8)} t} - e^{-(a'_{42})^{(8)} t}] + G_{42}^0 e^{-(a'_{42})^{(8)} t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)} - (b'_{42})^{(8)})}\left[e^{(R_1)^{(8)} t} - e^{-(b'_{42})^{(8)} t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)} t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)} + (r_{40})^{(8)} + (R_2)^{(8)})}\left[e^{((R_1)^{(8)} + (r_{40})^{(8)})t} - e^{-(R_2)^{(8)} t}\right] + T_{42}^0 e^{-(R_2)^{(8)} t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \le -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \le -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \le -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \le -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)}, , (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$
and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \ \boldsymbol{if}\ (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if}\ (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \ \boldsymbol{if}\ (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if}\ (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if}\ (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \le G_{44}(t) \le G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \le G_{45}(t) \le \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$$\left(\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0e^{-(S_2)^{(9)}t}\leq G_{46}(t)\leq\right.$$

$$\left.\frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}[e^{(S_1)^{(9)}t}-e^{-(a_{46}')^{(9)}t}]+G_{46}^0e^{-(a_{46}')^{(9)}t}\right)$$

$$\boxed{T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}}T_{44}^0e^{(R_1)^{(9)}t}\leq T_{44}(t)\leq\frac{1}{(\mu_2)^{(9)}}T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b_{46}')^{(9)}t}\right]+T_{46}^0e^{-(b_{46}')^{(9)}t}\leq T_{46}(t)\leq$$

$$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)},(S_2)^{(9)},(R_1)^{(9)},(R_2)^{(9)}$:-

Where $(S_1)^{(9)}=(a_{44})^{(9)}(m_2)^{(9)}-(a_{44}')^{(9)}$

$(S_2)^{(9)}=(a_{46})^{(9)}-(p_{46})^{(9)}$

$(R_1)^{(9)}=(b_{44})^{(9)}(\mu_2)^{(9)}-(b_{44}')^{(9)}$

$(R_2)^{(9)}=(b_{46}')^{(9)}-(r_{46})^{(9)}$

Proof : From global equations we obtain $\frac{dv^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right) - (a_{14}^{''})^{(1)}(T_{14},t)v^{(1)} - (a_{14})^{(1)}v^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have	386

Definition of $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
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In the same manner , we get	391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
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$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:-	403

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right) - (a''_{29})^{(5)}(T_{29}, t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains **Definition of** $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:- For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$ $\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}$, $\boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$ it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$	
In the same manner , we get $\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}$, $\boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$ From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$	409
If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, $(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$	410
If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain $(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(5)}(t)$:- $(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}$, $\boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(5)}(t)$:- $(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$	411

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>**Proof**</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ <u>**Definition of**</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains <u>**Definition of**</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \le \nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a_{40}')^{(8)} - (a_{41}')^{(8)} + (a_{40}'')^{(8)}(T_{41},t)\right) - (a_{41}'')^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:-	424

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

Proof : From 99,20,44,22,23,44 we obtain 424A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}^{''})^{(9)} = (a_{45}^{''})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}^{''})^{(9)} = (b_{45}^{''})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i^{''})^{(1)} and\ (b_i^{''})^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a_{14}^{'})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}^{'})^{(1)}(r_{14})^{(1)} - (b_{14}^{'})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

$with\ \ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ \ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ \ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ \ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ \ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i'')^{(6)} and\ (b_i'')^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}')^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}')^{(6)}(r_{33})^{(6)} - (b_{33}')^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})\right]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b'_{24})^{(4)} - (b''_{24})^{(4)}\big((G_{27})\big)\,]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b'_{25})^{(4)} - (b''_{25})^{(4)}\big((G_{27})\big)\,]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b'_{26})^{(4)} - (b''_{26})^{(4)}\big((G_{27})\big)\,]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (ii) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) +$	486

$(a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*}) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)} G_{14}}{[(a_{13}')^{(1)} + (a_{13}'')^{(1)}(T_{14}^{*})]}$, $G_{15} = \frac{(a_{15})^{(1)} G_{14}}{[(a_{15}')^{(1)} + (a_{15}'')^{(1)}(T_{14}^{*})]}$	493
Definition and uniqueness of T_{17}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*}) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)} G_{17}}{[(a_{16}')^{(2)} + (a_{16}'')^{(2)}(T_{17}^{*})]}$, $G_{18} = \frac{(a_{18})^{(2)} G_{17}}{[(a_{18}')^{(2)} + (a_{18}'')^{(2)}(T_{17}^{*})]}$	495
Definition and uniqueness of T_{21}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}')^{(3)} + (a_{20}'')^{(3)}(T_{21}^{*})]}$, $G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}')^{(3)} + (a_{22}'')^{(3)}(T_{21}^{*})]}$	496
Definition and uniqueness of T_{25}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^{*})]}$, $G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^{*})]}$	497
Definition and uniqueness of T_{29}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^{*})]}$, $G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^{*})]}$	498
Definition and uniqueness of T_{33}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T^*_{33})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T^*_{33})]}$	
Definition and uniqueness of T^*_{37} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T^*_{37} for which $f(T^*_{37}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T^*_{37})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T^*_{37})]}$	500
Definition and uniqueness of T^*_{41} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T^*_{41} for which $f(T^*_{41}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T^*_{41})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T^*_{41})]}$	501
Definition and uniqueness of T^*_{45} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T^*_{45} for which $f(T^*_{45}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T^*_{45})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T^*_{45})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b'_{13})^{(1)}(b''_{14})^{(1)}(G) + (b'_{14})^{(1)}(b''_{13})^{(1)}(G)\right] + (b''_{13})^{(1)}(G)(b''_{14})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{14} such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b'_{16})^{(2)}(b''_{17})^{(2)}(G_{19}) + (b'_{17})^{(2)}(b''_{16})^{(2)}(G_{19})\right] + (b''_{16})^{(2)}(G_{19})(b''_{17})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	
By the same argument, the equations admit solutions G_{20},G_{21} if $\varphi(G_{23})=(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23})+(b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20},G_{21},G_{22}),G_{20},G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24},G_{25} if $\varphi(G_{27})=(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27})+(b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right]+(b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24},G_{25},G_{26}),G_{24},G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28},G_{29} if $\varphi(G_{31})=(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31})+(b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right]+(b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28},G_{29},G_{30}),G_{28},G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32},G_{33} if $\varphi(G_{35})=(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35})+(b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right]+(b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32},G_{33},G_{34}),G_{32},G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*})=0$	508
By the same argument, the equations admit solutions G_{36},G_{37} if $\varphi(G_{39})=(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39})+(b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right]+(b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36},G_{37},G_{38}),G_{36},G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0,\varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*})=0$	509
By the same argument, the equations admit solutions G_{40},G_{41} if	510

$\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - \left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*) = 0$	
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{45} such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G^*_{14} given by $\varphi(G^*) = 0$, T^*_{14} given by $f(T^*_{14}) = 0$ and $G^*_{13} = \frac{(a_{13})^{(1)}G^*_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G^*_{15} = \frac{(a_{15})^{(1)}G^*_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$ $T^*_{13} = \frac{(b_{13})^{(1)}T^*_{14}}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T^*_{15} = \frac{(b_{15})^{(1)}T^*_{14}}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G^*_{17} given by $\varphi((G_{19})^*) = 0$, T^*_{17} given by $f(T^*_{17}) = 0$ and	512
$G^*_{16} = \frac{(a_{16})^{(2)}G^*_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G^*_{18} = \frac{(a_{18})^{(2)}G^*_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	513
$T^*_{16} = \frac{(b_{16})^{(2)}T^*_{17}}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T^*_{18} = \frac{(b_{18})^{(2)}T^*_{17}}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G^*_{21} given by $\varphi((G_{23})^*) = 0$, T^*_{21} given by $f(T^*_{21}) = 0$ and $G^*_{20} = \frac{(a_{20})^{(3)}G^*_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G^*_{22} = \frac{(a_{22})^{(3)}G^*_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$ $T^*_{20} = \frac{(b_{20})^{(3)}T^*_{21}}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T^*_{22} = \frac{(b_{22})^{(3)}T^*_{21}}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27})=0$, T_{25}^* given by $f(T_{25}^*)=0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a'_{24})^{(4)}+(a''_{24})^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a'_{26})^{(4)}+(a''_{26})^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b'_{24})^{(4)}-(b''_{24})^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b'_{26})^{(4)}-(b''_{26})^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*)=0$, T_{29}^* given by $f(T_{29}^*)=0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a'_{28})^{(5)}+(a''_{28})^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a'_{30})^{(5)}+(a''_{30})^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b'_{28})^{(5)}-(b''_{28})^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b'_{30})^{(5)}-(b''_{30})^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*)=0$, T_{33}^* given by $f(T_{33}^*)=0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a'_{32})^{(6)}+(a''_{32})^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a'_{34})^{(6)}+(a''_{34})^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b'_{32})^{(6)}-(b''_{32})^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b'_{34})^{(6)}-(b''_{34})^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*)=0$, T_{37}^* given by $f(T_{37}^*)=0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a'_{36})^{(7)}+(a''_{36})^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a'_{38})^{(7)}+(a''_{38})^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b'_{36})^{(7)}-(b''_{36})^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b'_{38})^{(7)}-(b''_{38})^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*)=0$, T_{41}^* given by $f(T_{41}^*)=0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a'_{40})^{(8)}+(a''_{40})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a'_{42})^{(8)}+(a''_{42})^{(8)}(T_{41}^*)]}$	523

$T_{40}^{*} = \frac{(b_{40})^{(8)} T_{41}^{*}}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^{*})]}$, $T_{42}^{*} = \frac{(b_{42})^{(8)} T_{41}^{*}}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^{*})]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^{*} given by $\varphi((G_{47})^{*}) = 0$, T_{45}^{*} given by $f(T_{45}^{*}) = 0$ and $G_{44}^{*} = \frac{(a_{44})^{(9)} G_{45}^{*}}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46}^{*} = \frac{(a_{46})^{(9)} G_{45}^{*}}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^{*})]}$ $T_{44}^{*} = \frac{(b_{44})^{(9)} T_{45}^{*}}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^{*})]}$, $T_{46}^{*} = \frac{(b_{46})^{(9)} T_{45}^{*}}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^{*})]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **<u>Definition of</u>** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i$, $T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^{*}) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^{*}) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^{*}\mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^{*}\mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^{*}\mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^{*}\mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^{*}\mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^{*}\mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS **<u>Theorem 4:</u>** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}(\,(G_{31})^{*}\,) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt}=-\left((a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\mathbb{G}_{28}+(a_{28})^{(5)}\mathbb{G}_{29}-(q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt}=-\left((a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)\mathbb{G}_{29}+(a_{29})^{(5)}\mathbb{G}_{28}-(q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt}=-\left((a_{30}^{'})^{(5)}+(p_{30})^{(5)}\right)\mathbb{G}_{30}+(a_{30})^{(5)}\mathbb{G}_{29}-(q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt}=-\left((b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)\mathbb{T}_{28}+(b_{28})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_{j}\right)$	560
$\frac{d\mathbb{T}_{29}}{dt}=-\left((b_{29}^{'})^{(5)}-(r_{29})^{(5)}\right)\mathbb{T}_{29}+(b_{29})^{(5)}\mathbb{T}_{28}+\sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_{j}\right)$	561
$\frac{d\mathbb{T}_{30}}{dt}=-\left((b_{30}^{'})^{(5)}-(r_{30})^{(5)}\right)\mathbb{T}_{30}+(b_{30})^{(5)}\mathbb{T}_{29}+\sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_{j}\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad , T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*})=(q_{33})^{(6)} \quad , \frac{\partial(b_i^{''})^{(6)}}{\partial G_j}\left((G_{35})^{*}\right)=s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt}=-\left((a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\mathbb{G}_{32}+(a_{32})^{(6)}\mathbb{G}_{33}-(q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt}=-\left((a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)\mathbb{G}_{33}+(a_{33})^{(6)}\mathbb{G}_{32}-(q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt}=-\left((a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)\mathbb{G}_{34}+(a_{34})^{(6)}\mathbb{G}_{33}-(q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt}=-\left((b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)\mathbb{T}_{32}+(b_{32})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_{j}\right)$	568
$\frac{d\mathbb{T}_{33}}{dt}=-\left((b_{33}^{'})^{(6)}-(r_{33})^{(6)}\right)\mathbb{T}_{33}+(b_{33})^{(6)}\mathbb{T}_{32}+\sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_{j}\right)$	569
$\frac{d\mathbb{T}_{34}}{dt}=-\left((b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\mathbb{T}_{34}+(b_{34})^{(6)}\mathbb{T}_{33}+\sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_{j}\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}(\ (G_{39})^{**}\ ) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\ \mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}(\ (G_{43})^*\ ) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*}) = (q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b_{45}^{'})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)} + (a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*} + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$$

$$+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right) \left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\} = 0$$

+

$$\left((\lambda)^{(2)} + (b_{18}')^{(2)} - (r_{18})^{(2)}\right)\{\left((\lambda)^{(2)} + (a_{18}')^{(2)} + (p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^{*} + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^{*}\right)$$

$$+\left(\left((\lambda)^{(2)} + (a_{17}')^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^{*} + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*}\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}')^{(2)} + (b_{17}')^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right) (q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}\right) \left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^{*} + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^{*}\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^{*} + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^{*}\right)\} = 0$$

+

$$\left((\lambda)^{(3)} + (b_{22}')^{(3)} - (r_{22})^{(3)}\right)\{\left((\lambda)^{(3)} + (a_{22}')^{(3)} + (p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)} + (a_{20}')^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$$

$$+\left(\left((\lambda)^{(3)} + (a_{21}')^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*} + (a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$$

$$\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$$

$\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}')^{(3)} + (a_{21}')^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2 + \left((b_{20}')^{(3)} + (b_{21}')^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}')^{(3)} + (a_{21}')^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right) (q_{22})^{(3)} G_{22}$ $+\left((\lambda)^{(3)} + (a_{20}')^{(3)} + (p_{20})^{(3)}\right) \left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\} = 0$ +	
$\left((\lambda)^{(4)} + (b_{26}')^{(4)} - (r_{26})^{(4)}\right)\{\left((\lambda)^{(4)} + (a_{26}')^{(4)} + (p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)} + (a_{24}')^{(4)} + (p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)} + (b_{24}')^{(4)} - (r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)} + (a_{25}')^{(4)} + (p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}')^{(4)} - (r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}')^{(4)} + (a_{25}')^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((b_{24}')^{(4)} + (b_{25}')^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}')^{(4)} + (a_{25}')^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right) (q_{26})^{(4)} G_{26}$ $+\left((\lambda)^{(4)} + (a_{24}')^{(4)} + (p_{24})^{(4)}\right) \left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}')^{(4)} - (r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$\left((\lambda)^{(5)} + (b_{30}')^{(5)} - (r_{30})^{(5)}\right)\{\left((\lambda)^{(5)} + (a_{30}')^{(5)} + (p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)} + (a_{28}')^{(5)} + (p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)} + (b_{28}')^{(5)} - (r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(\left((\lambda)^{(5)} + (a_{29}')^{(5)} + (p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(\left((\lambda)^{(5)} + (b_{28}')^{(5)} - (r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$$\left(\left((\lambda)^{(5)}\right)^2+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^2+\left((b_{28}')^{(5)}+(b_{29}')^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^2+\left((a_{28}')^{(5)}+(a_{29}')^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}')^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^*+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^*\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}')^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^*+(b_{29})^{(5)}s_{(28),(30)}T_{28}^*\right)\}=0$$

$+$

$$\left((\lambda)^{(6)}+(b_{34}')^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}')^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^*+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^*\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^*+(b_{33})^{(6)}s_{(32),(33)}T_{33}^*\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}')^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^*+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^*\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^*+(b_{33})^{(6)}s_{(32),(32)}T_{32}^*\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2+\left((b_{32}')^{(6)}+(b_{33}')^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2+\left((a_{32}')^{(6)}+(a_{33}')^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}')^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^*+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^*\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}')^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^*+(b_{33})^{(6)}s_{(32),(34)}T_{32}^*\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}')^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}')^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^*+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^*\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^*+(b_{37})^{(7)}s_{(36),(37)}T_{37}^*\right)$$

$$+\left(\left((\lambda)^{(7)}+(a_{37}')^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^*+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^*\right)$$

$$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^*+(b_{37})^{(7)}s_{(36),(36)}T_{36}^*\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right) (q_{38})^{(7)} G_{38}$$

$$+\left((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)}\right) \left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(\left((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\} = 0$$

$+$

$$\left((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\{\left((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(\left((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right) (q_{42})^{(8)} G_{42}$$

$$+\left((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right) \left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$$

$+$

$$\left((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)}\right)\{\left((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(\left((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION THIRTY FIVE

Limit Of The NMSSM Higgs Sector

INTRODUCTION—VARIABLES USED

On the Alignment Limit of the NMSSM Higgs Sector Marcela Carena, Howard E. Haber, Ian Low, Nausheen R. Shah, Carlos E. M. Wagner (Submitted on 30 Oct 2015)

(1) The Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM) with (e&eb) a Higgs boson of mass 125 GeV can be compatible with (=) stop masses of order of the electroweak scale, thereby reducing (e) the degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking.

(2) Moreover, in an attractive region of (e) the NMSSM parameter space, corresponding to (e&eb) the "alignment limit" in which one of the neutral Higgs fields lies approximately in (eb) the same direction in field space as (=) the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties.

(3) Authors derive analytical expressions for the alignment conditions and show that (eb) they point toward a more natural region of parameter space for (e) electroweak symmetry breaking, while allowing (eb) for perturbativity of the theory up to the Planck scale.

(4) Moreover, the alignment limit in (eb) the NMSSM leads to (eb) a well defined spectrum in (eb) the Higgs and Higgsino sectors, and yields (eb) a rich and interesting Higgs boson phenomenology that can be tested at the LHC.

(5) Authors discuss the most promising channels for discovery and present several benchmark points for further study. Subjects: High Energy Physics - Phenomenology (hep-ph); High Energy Physics -

Experiment (hep-ex) Journal reference: Phys. Rev. D 93, 035013 (2016) DOI: 10.1103/PhysRevD.93.035013 Cite as: arXiv: 1510.09137 [hep-ph] (or arXiv: 1510.09137v1 [hep-ph] for this version) **New LHC Benchmarks for the CP-conserving Two-Higgs-Doublet Model Howard E. Haber, Oscar Stal** **(6)** Authors introduce a strategy to study the parameter space of (e) the general, CP-conserving, two-Higgs-doublet Model (2HDM) with (e&eb) a softly broken Z_2-symmetry by means of (e) a new "hybrid" basis. **(7)** In this basis the input parameters are (=) the measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength to (e&eb) vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters. **(8)** Using the hybrid basis, authors present numerical scans of the 2HDM parameter space where (e)authors survey available parameter regions and analyze model constraints. **(9)** From these results, authors define a number of benchmark scenarios that capture (e) different aspects of non-standard Higgs phenomenology that are of interest for future LHC Higgs searches. Subjects: High Energy Physics - Phenomenology (hep-ph); High Energy Physics - Experiment (hep-ex) Report number: SCIPP-15/10 Cite as: arXiv:1507.04281 [hep-ph] (or arXiv:1507.04281v3 [hep-ph] for this version)	
NOTATION	
Module One The Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM) with (e&eb) a Higgs boson of mass 125 GeV can be compatible with (=) stop masses of order of the electroweak scale, thereby reducing (e) the degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking	
G_{13} : Category one of **Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM)** ; Higgs boson of mass 125 GeV can be compatible with (=) stop masses of order of the electroweak scale, thereby reducing (e) the degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking G_{14} : Category two of SAS G_{15} : Category three of SAS	
T_{13} : Category one of Higgs boson of mass 125 GeV can be compatible with (=) stop masses of order of the electroweak scale, thereby reducing (e) the degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking;**Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM)** T_{14} : Category two of SAS T_{15} : Category three of SAS	
Module Two The Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM) with a Higgs boson of mass 125 GeV can be compatible with (=) stop masses of order of the electroweak scale, thereby reducing (e) the degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking	

G_{16} : Category one of Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM) with a Higgs boson of mass 125 GeV G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of stop masses of order of the electroweak scale, thereby reducing (e) the degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three The Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM) with a Higgs boson of mass 125 GeV can be compatible with stop masses of order of the electroweak scale, thereby reducing (e) the degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking	
G_{20} : Category one of degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM) with a Higgs boson of mass 125 GeV can be compatible with stop masses of order of the electroweak scale T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four The Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM) with a Higgs boson of mass 125 GeV can be compatible with stop masses of order of the electroweak scale, thereby reducing the degree of fine-tuning necessary to achieve (e) electroweak symmetry breaking	
G_{24} : Category one of Next-to-Minimal Supersymmetric extension of the Standard Model (NMSSM) with a Higgs boson of mass 125 GeV can be compatible with stop masses of order of the electroweak scale, thereby reducing the degree of fine-tuning necessary G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of electroweak symmetry breaking T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five Moreover, in an attractive region of the NMSSM parameter space, corresponding to (e&eb) the "alignment limit" in which one of the neutral Higgs fields lies approximately in (eb) the same direction in field space as	

(=) the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties	
G_{28} : Category one of **region of the NMSSM parameter space;** "alignment limit" in which one of the neutral Higgs fields lies approximately in (eb) the same direction in field space as (=) the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of "alignment limit" in which one of the neutral Higgs fields lies approximately in (eb) the same direction in field space as (=) the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties **;region of the NMSSM parameter space** T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six Moreover, in an attractive region of the NMSSM parameter space, corresponding to the "alignment limit" in which one of the neutral Higgs fields lies approximately in (eb) the same direction in field space as (=) the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties	
G_{32} : Category one of region of the NMSSM parameter space, corresponding to the "alignment limit" in which one of the neutral Higgs fields lies approximately G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of same direction in field space as (=) the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven Moreover, in an attractive region of the NMSSM parameter space, corresponding to the "alignment limit" in which one of the neutral Higgs fields lies approximately in the same direction in field space as (=) the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties	
G_{36} : Category one of region of the NMSSM parameter space, corresponding to the "alignment limit" in which one of the neutral Higgs fields lies approximately in the same direction in field space	

G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight Moreover, in an attractive region of the NMSSM parameter space, corresponding to the "alignment limit" in which one of the neutral Higgs fields lies approximately in the same direction in field space as the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted to have (e) Standard-Model-like properties	
G_{40} : Category one of Standard-Model-like properties G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of region of the NMSSM parameter space, corresponding to the "alignment limit" in which one of the neutral Higgs fields lies approximately in the same direction in field space as the doublet Higgs vacuum expectation value, the observed Higgs boson is predicted T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine Moreover, the alignment limit in the NMSSM leads to (eb) a well defined spectrum in (eb) the Higgs and Higgsino sectors, and yields (eb) a rich and interesting Higgs boson phenomenology that can be tested at the LHC	
G_{44} : Category one of alignment limit in the NMSSM G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of well defined spectrum in (eb) the Higgs and Higgsino sectors, and yields (eb) a rich and interesting Higgs boson phenomenology that can be tested at the LHC T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	

$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}, t)\right] G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}, t)\right] G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}, t)\right] G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G, t)\right] T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G, t)\right] T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G, t)\right] T_{15}$	6
$+(a''_{13})^{(1)}(T_{14}, t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G, t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)} G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right] G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)} G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}, t)\right] G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)} G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17}, t)\right] G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)} T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\big((G_{19}), t\big)\right] T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)} T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\big((G_{19}), t\big)\right] T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)} T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\big((G_{19}), t\big)\right] T_{18}$	12
$+(a''_{16})^{(2)}(T_{17}, t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\big((G_{19}), t\big) =$ First detritions factor	
Module Numbered Three	

The differential system of this model is now (Module numbered three)	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\left[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt}=(a_{21})^{(3)}G_{20}-\left[(a'_{21})^{(3)}+(a''_{21})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt}=(a_{22})^{(3)}G_{21}-\left[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt}=(b_{20})^{(3)}T_{21}-\left[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt}=(b_{21})^{(3)}T_{20}-\left[(b'_{21})^{(3)}-(b''_{21})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt}=(b_{22})^{(3)}T_{21}-\left[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a''_{20})^{(3)}(T_{21},t)=$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23},t)=$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt}=(a_{24})^{(4)}G_{25}-\left[(a'_{24})^{(4)}+(a''_{24})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\left[(a'_{25})^{(4)}+(a''_{25})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\left[(a'_{26})^{(4)}+(a''_{26})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[(b'_{24})^{(4)}-(b''_{24})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\left[(b'_{25})^{(4)}-(b''_{25})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\left[(b'_{26})^{(4)}-(b''_{26})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a''_{24})^{(4)}(T_{25},t)=$ **First augmentation factor**	
$-(b''_{24})^{(4)}\left((G_{27}),t\right)=$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\left[(a'_{28})^{(5)}+(a''_{28})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\left[(a'_{29})^{(5)}+(a''_{29})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt}=(a_{30})^{(5)}G_{29}-\left[(a'_{30})^{(5)}+(a''_{30})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[(b'_{28})^{(5)}-(b''_{28})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[(b'_{29})^{(5)}-(b''_{29})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[(b'_{30})^{(5)}-(b''_{30})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a''_{28})^{(5)}(T_{29},t)=$ **First augmentation factor**	
$-(b''_{28})^{(5)}\left((G_{31}),t\right)=$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[(a'_{32})^{(6)}+(a''_{32})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\left[(a'_{33})^{(6)}+(a''_{33})^{(6)}(T_{33},t)\right]G_{33}$	32

$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}, t)\right] G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[(b_{32}')^{(6)} - (b_{32}'')^{(6)}\left((G_{35}), t\right)\right] T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[(b_{33}')^{(6)} - (b_{33}'')^{(6)}\left((G_{35}), t\right)\right] T_{33}$	35
$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[(b_{34}')^{(6)} - (b_{34}'')^{(6)}\left((G_{35}), t\right)\right] T_{34}$	36
$+(a_{32}'')^{(6)}(T_{33}, t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}, t)\right] G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37}, t)\right] G_{37}$	*38*
$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}, t)\right] G_{38}$	*39*
$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b_{36}')^{(7)} - (b_{36}'')^{(7)}\left((G_{39}), t\right)\right] T_{36}$	*40*
$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b_{37}')^{(7)} - (b_{37}'')^{(7)}\left((G_{39}), t\right)\right] T_{37}$	*41*
$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b_{38}')^{(7)} - (b_{38}'')^{(7)}\left((G_{39}), t\right)\right] T_{38}$	*42*
$+(a_{36}'')^{(7)}(T_{37}, t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)} G_{41} - \left[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}, t)\right] G_{40}$	*43*
$\frac{dG_{41}}{dt} = (a_{41})^{(8)} G_{40} - \left[(a_{41}')^{(8)} + (a_{41}'')^{(8)}(T_{41}, t)\right] G_{41}$	*44*
$\frac{dG_{42}}{dt} = (a_{42})^{(8)} G_{41} - \left[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}, t)\right] G_{42}$	*45*
$\frac{dT_{40}}{dt} = (b_{40})^{(8)} T_{41} - \left[(b_{40}')^{(8)} - (b_{40}'')^{(8)}\left((G_{43}), t\right)\right] T_{40}$	*46*
$\frac{dT_{41}}{dt} = (b_{41})^{(8)} T_{40} - \left[(b_{41}')^{(8)} - (b_{41}'')^{(8)}\left((G_{43}), t\right)\right] T_{41}$	*47*
$\frac{dT_{42}}{dt} = (b_{42})^{(8)} T_{41} - \left[(b_{42}')^{(8)} - (b_{42}'')^{(8)}\left((G_{43}), t\right)\right] T_{42}$	*48*
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)} G_{45} - \left[(a_{44}')^{(9)} + (a_{44}'')^{(9)}(T_{45}, t)\right] G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)} G_{44} - \left[(a_{45}')^{(9)} + (a_{45}'')^{(9)}(T_{45}, t)\right] G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)} G_{45} - \left[(a_{46}')^{(9)} + (a_{46}'')^{(9)}(T_{45}, t)\right] G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)} T_{45} - \left[(b_{44}')^{(9)} - (b_{44}'')^{(9)}\left((G_{47}), t\right)\right] T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)} T_{44} - \left[(b_{45}')^{(9)} - (b_{45}'')^{(9)}\left((G_{47}), t\right)\right] T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)} T_{45} - \left[(b_{46}')^{(9)} - (b_{46}'')^{(9)}\left((G_{47}), t\right)\right] T_{46}$	54
$+(a_{44}'')^{(9)}(T_{45}, t) =$ **First augmentation factor**	
$-(b_{44}'')^{(9)}\left((G_{47}), t\right) =$ **First detrition factor**	

$$\frac{dG_{13}}{dt} = (a_{13})^{(1)} G_{14} - \begin{bmatrix} (a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 55

$$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \begin{bmatrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$ 56

$$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \begin{bmatrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$ 57

Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \begin{bmatrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$ 58

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \begin{bmatrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$ 59

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \begin{bmatrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$ 60

Where $\boxed{-(b_{13}'')^{(1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{36}'')^{(7,7,)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{40}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{41}'')^{(8,8)}(G_{43},t)}$ $\boxed{-(b_{42}'')^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{44}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}'')^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[\begin{matrix}(a_{16}')^{(2)}\boxed{+(a_{16}'')^{(2)}(T_{17},t)}\boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)}\boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{32}'')^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{36}'')^{(7,7,7)}(T_{37},t)}\boxed{+(a_{40}'')^{(8,8,8)}(T_{41},t)}\boxed{+(a_{44}'')^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{16}$	61
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[\begin{matrix}(a_{17}')^{(2)}\boxed{+(a_{17}'')^{(2)}(T_{17},t)}\boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)}\boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{33}'')^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{37}'')^{(7,7,7)}(T_{37},t)}\boxed{+(a_{41}'')^{(8,8,8)}(T_{41},t)}\boxed{+(a_{45}'')^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{17}$	62
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[\begin{matrix}(a_{18}')^{(2)}\boxed{+(a_{18}'')^{(2)}(T_{17},t)}\boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)}\boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{34}'')^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{38}'')^{(7,7,7)}(T_{37},t)}\boxed{+(a_{42}'')^{(8,8,8)}(T_{41},t)}\boxed{+(a_{46}'')^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{18}$	63
Where $\boxed{+(a_{16}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a_{13}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{20}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{24}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}'')^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}'')^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a_{28}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation	

coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} \boxed{-(b''_{16})^{(2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,)}(G,t)} \boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} \boxed{-(b''_{17})^{(2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,)}(G,t)} \boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{matrix} \right] T_{18}$	66
where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3 $\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3	

$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{20}$	67
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21}$	68
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22}$	69
$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{20}$	70
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21}$	71

$\frac{dT_{22}}{dt} = (b_{22})^{(3)} T_{21} - \left[\begin{matrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{matrix} \right] T_{22}$	72
$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{13})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3* $\boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3* $\boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)} G_{25} - \left[\begin{matrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{24}$	73
$\frac{dG_{25}}{dt} = (a_{25})^{(4)} G_{24} - \left[\begin{matrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{25}$	74
$\frac{dG_{26}}{dt} = (a_{26})^{(4)} G_{25} - \left[\begin{matrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{26}$	75
$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1,2\ \ 3$ $\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ $are\ second\ \ augmentation\ coefficient\ \ for\ category\ 1,2\ and\ 3$ $\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ $are\ third\ \ augmentation\ coefficient\ for\ category\ 1,2\ and\ 3$	

$\boxed{+(a_{13}'')^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1)}(T_{14},t)}$

are fourth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a_{16}'')^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2)}(T_{17},t)}$

are fifth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a_{20}'')^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3)}(T_{21},t)}$

are sixth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a_{36}'')^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7)}(T_{37},t)}$

are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a_{40}'')^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{41}'')^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a_{42}'')^{(8,8,8,8,8)}(T_{41},t)}$

are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a_{46}'')^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{45}'')^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a_{44}'')^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b_{24}')^{(4)} \boxed{-(b_{24}'')^{(4)}(G_{27},t)} \boxed{-(b_{28}'')^{(5,5,)}(G_{31},t)} \boxed{-(b_{32}'')^{(6,6,)}(G_{35},t)} \\ \boxed{-(b_{13}'')^{(1,1,1,1)}(G,t)} \boxed{-(b_{16}'')^{(2,2,2,2)}(G_{19},t)} \boxed{-(b_{20}'')^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{36}'')^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{40}'')^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{44}'')^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b_{25}')^{(4)} \boxed{-(b_{25}'')^{(4)}(G_{27},t)} \boxed{-(b_{29}'')^{(5,5,)}(G_{31},t)} \boxed{-(b_{33}'')^{(6,6,)}(G_{35},t)} \\ \boxed{-(b_{14}'')^{(1,1,1,1)}(G,t)} \boxed{-(b_{17}'')^{(2,2,2,2)}(G_{19},t)} \boxed{-(b_{21}'')^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{37}'')^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{41}'')^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{45}'')^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b_{26}')^{(4)} \boxed{-(b_{26}'')^{(4)}(G_{27},t)} \boxed{-(b_{30}'')^{(5,5,)}(G_{31},t)} \boxed{-(b_{34}'')^{(6,6,)}(G_{35},t)} \\ \boxed{-(b_{15}'')^{(1,1,1,1)}(G,t)} \boxed{-(b_{18}'')^{(2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}'')^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}'')^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}'')^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}'')^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26} \quad 78$$

Where $\boxed{-(b_{24}'')^{(4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{28}'')^{(5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{32}'')^{(6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{13}'')^{(1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,1)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b_{16}'')^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}'')^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}'')^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b_{20}'')^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}'')^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}'')^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b_{36}'')^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}'')^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b_{40}'')^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$-(b''_{46})^{(9,9,9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9,9,9)}(G_{47},t)$, $-(b''_{44})^{(9,9,9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1 2 3	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a'_{28})^{(5)} +(a''_{28})^{(5)}(T_{29},t) +(a''_{24})^{(4,4,)}(T_{25},t) +(a''_{32})^{(6,6,6)}(T_{33},t) \\ +(a''_{13})^{(1,1,1,1,1)}(T_{14},t) +(a''_{16})^{(2,2,2,2,2)}(T_{17},t) +(a''_{20})^{(3,3,3,3,3)}(T_{21},t) \\ +(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t) +(a''_{44})^{(9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{28}$	79
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a'_{29})^{(5)} +(a''_{29})^{(5)}(T_{29},t) +(a''_{25})^{(4,4,)}(T_{25},t) +(a''_{33})^{(6,6,6)}(T_{33},t) \\ +(a''_{14})^{(1,1,1,1,1)}(T_{14},t) +(a''_{17})^{(2,2,2,2,2)}(T_{17},t) +(a''_{21})^{(3,3,3,3,3)}(T_{21},t) \\ +(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t) +(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t) +(a''_{45})^{(9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{29}$	80
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a'_{30})^{(5)} +(a''_{30})^{(5)}(T_{29},t) +(a''_{26})^{(4,4,)}(T_{25},t) +(a''_{34})^{(6,6,6)}(T_{33},t) \\ +(a''_{15})^{(1,1,1,1,1)}(T_{14},t) +(a''_{18})^{(2,2,2,2,2)}(T_{17},t) +(a''_{22})^{(3,3,3,3,3)}(T_{21},t) \\ +(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t) +(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t) +(a''_{46})^{(9,9,9,9,9)}(T_{45},t) \end{bmatrix} G_{30}$	81
Where $+(a''_{28})^{(5)}(T_{29},t)$, $+(a''_{29})^{(5)}(T_{29},t)$, $+(a''_{30})^{(5)}(T_{29},t)$ *are first augmentation coefficients for category* 1, 2 *and* 3 *And* $+(a''_{24})^{(4,4,)}(T_{25},t)$, $+(a''_{25})^{(4,4,)}(T_{25},t)$, $+(a''_{26})^{(4,4,)}(T_{25},t)$ *are second augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{32})^{(6,6,6)}(T_{33},t)$, $+(a''_{33})^{(6,6,6)}(T_{33},t)$, $+(a''_{34})^{(6,6,6)}(T_{33},t)$ *are third augmentation coefficient for category* 1, 2 *and* 3 $+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)$, $+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)$, $+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)$ are fourth augmentation coefficients for category 1,2, and 3 $+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)$, $+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)$, $+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)$ are fifth augmentation coefficients for category 1,2,and 3 $+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)$, $+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)$, $+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)$ are sixth augmentation coefficients for category 1,2, 3 $+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1,2, 3 $+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)$ are eighth augmentation coefficients for category 1,2, 3 $+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)$, $+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \begin{bmatrix} (b'_{28})^{(5)} -(b''_{28})^{(5)}(G_{31},t) -(b''_{24})^{(4,4,)}(G_{27},t) -(b''_{32})^{(6,6,6)}(G_{35},t) \\ -(b''_{13})^{(1,1,1,1,1)}(G,t) -(b''_{16})^{(2,2,2,2,2)}(G_{19},t) -(b''_{20})^{(3,3,3,3,3)}(G_{23},t) \\ -(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t) -(b''_{44})^{(9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \begin{bmatrix} (b'_{29})^{(5)} -(b''_{29})^{(5)}(G_{31},t) -(b''_{25})^{(4,4,)}(G_{27},t) -(b''_{33})^{(6,6,6)}(G_{35},t) \\ -(b''_{14})^{(1,1,1,1,1)}(G,t) -(b''_{17})^{(2,2,2,2,2)}(G_{19},t) -(b''_{21})^{(3,3,3,3,3)}(G_{23},t) \\ -(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t) -(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t) -(b''_{45})^{(9,9,9,9,9)}(G_{47},t) \end{bmatrix} T_{29}$	83

$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$	84
where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)} G_{33} - \begin{bmatrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{32}$	85
$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \begin{bmatrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{33}$	86
$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \begin{bmatrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{34}$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation*	

$coefficients\ for\ category$ 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients

$\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \begin{bmatrix} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{32} \quad 88$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33} \quad 89$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34} \quad 90$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ $are\ first\ detrition\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ $are\ second\ detrition\ coefficients\ for\ category$ 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ $are\ third\ detrition\ coefficients\ for\ category$ 1,2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$	*91*
$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$	*92*
$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$	*93*
Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{36}}{dt} =$	94

$$(b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)}\boxed{-(b''_{36})^{(7)}(G_{39},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{37}}{dt} =$$

$$(b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)}\boxed{-(b''_{37})^{(7)}(G_{39},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} =$$

$$(b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)}\boxed{-(b''_{38})^{(7)}(G_{39},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$

are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)}\boxed{+(a''_{40})^{(8)}(T_{41},t)} & \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13} \quad (95)$$

$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$,$\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$,$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$	
$\frac{dT_{41}}{dt} =$	

$$(b_{41})^{(8)}T_{40}-\left[\begin{matrix}(b_{41}^{'})^{(8)}\boxed{-(b_{41}^{''})^{(8)}(G_{43},t)} & \boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{14}$$

$$\frac{dT_{42}}{dt}=$$

$$(b_{42})^{(8)}T_{41}-\left[\begin{matrix}(b_{42}^{'})^{(8)}\boxed{-(b_{42}^{''})^{(8)}(G_{43},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{15}$$

Where $\boxed{-(b_{36}^{''})^{(7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{38}^{''})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{44}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

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$$\frac{dG_{44}}{dt}=(a_{44})^{(9)}G_{45}-\left[\begin{matrix}(a_{44}^{'})^{(9)}\boxed{+(a_{44}^{''})^{(9)}(T_{45},t)} & \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}\end{matrix}\right]G_{13}$$

$$\frac{dG_{45}}{dt}=(a_{45})^{(9)}G_{44}-\left[\begin{matrix}(a_{45}^{'})^{(9)}\boxed{+(a_{45}^{''})^{(9)}(T_{45},t)} & \boxed{+(a_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} & \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} & \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} & \boxed{+(a_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}\end{matrix}\right]G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45} - \left[\begin{matrix} (b_{46}^{'})^{(9)} \boxed{-(b_{46}^{''})^{(9)}(G_{47},t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{matrix} \right] T_{15}$	
Where $\boxed{-(b_{44}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9)}(G_{47},t)}$, $\boxed{-(b_{46}^{''})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{16}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{20}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{24}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{28}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{32}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{15}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b_{13}^{''})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{37}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{36}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b_{42}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{40}^{''})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i^{''})^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i^{''})^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b_i^{'})^{(1)} \leq (\hat{B}_{13})^{(1)}$	97
$lim_{T_2 \to \infty} (a_i^{''})^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b_i^{''})^{(1)} (G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\|(a_i^{''})^{(1)}(T_{14}^{'},t)-(a_i^{''})^{(1)}(T_{14},t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14}-T_{14}^{'}\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b_i^{''})^{(1)}(G^{'},t)-(b_i^{''})^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G-G^{'}\|\|e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(1)}(T_{14}^{'},t)$ and $(a_i^{''})^{(1)}(T_{14},t)$. $(T_{14}^{'},t)$ and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i^{''})^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i^{''})^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i^{'})^{(1)},(b_i)^{(1)},(b_i^{'})^{(1)},(p_i)^{(1)},(r_i)^{(1)}, i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i^{'})^{(1)}+(\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)}+(b_i^{'})^{(1)}+(\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	101
Where we suppose	
$(a_i)^{(2)},(a_i^{'})^{(2)},(a_i^{''})^{(2)},(b_i)^{(2)},(b_i^{'})^{(2)},(b_i^{''})^{(2)} > 0, \quad i,j=16,17,18$	
The functions $(a_i^{''})^{(2)},(b_i^{''})^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i^{''})^{(2)}(T_{17},t) \leq (p_i)^{(2)} \leq (\hat{A}_{16})^{(2)}$	102
$(b_i^{''})^{(2)}(G_{19},t) \leq (r_i)^{(2)} \leq (b_i^{'})^{(2)} \leq (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i^{''})^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i^{''})^{(2)}((G_{19}),t)= (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},(r_i)^{(2)}$ are positive constants and $i=16,17,18$	106
They satisfy Lipschitz condition:	

$\lvert (a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert (b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert (G_{19})-(G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},$ are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
<u>Definition of</u> $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)}+(a_i')^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i')^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(3)},\ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21},t)\leq(p_i)^{(3)}\leq(\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t)\leq\ (r_i)^{(3)}\leq(b_i')^{(3)}\leq(\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}(T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}(G_{23},t)=\ (r_i)^{(3)}$ **<u>Definition of</u>** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}$ are positive constants and $i=20,21,22$	113

They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}',t)-(a_i'')^{(3)}(T_{21},t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21}-T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}',t)-(b_i'')^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23}-G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and $(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)}=1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)},(r_i)^{(3)}, i=20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)}+(a_i')^{(3)}+(\hat{A}_{20})^{(3)}+(\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}]<1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)}+(b_i')^{(3)}+(\hat{B}_{20})^{(3)}+(\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}]<1$	116
Where we suppose	
$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)}>0, \quad i,j=24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)}, (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t)=(p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t)=(r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},(r_i)^{(4)}$ are positive constants and $i=24,25,26$	118
They satisfy Lipschitz condition:	119

$\lvert(a_i'')^{(4)}(T_{25}',t)-(a_i'')^{(4)}(T_{25},t)\rvert \le (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i'')^{(4)}((G_{27})',t)-(b_i'')^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and$(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}\right]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\ ,\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
Definition of $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(p_i)^{(4)},\ (r_i)^{(4)},i=24,25,26,$ satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[\,(a_i)^{(4)}+(a_i')^{(4)}+\ (\hat{A}_{24})^{(4)}+\ (\hat{P}_{24})^{(4)}\,(\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[\ (b_i)^{(4)}+(b_i')^{(4)}+\ (\hat{B}_{24})^{(4)}+\ (\hat{Q}_{24})^{(4)}\ \ (\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i')^{(5)},(a_i'')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(b_i'')^{(5)}>0,\quad i,j=28,29,30$ The functions $(a_i'')^{(5)},(b_i'')^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)},\ (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t)\le(p_i)^{(5)}\le(\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}),t)\le\ (r_i)^{(5)}\le(b_i')^{(5)}\le(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i'')^{(5)}\,(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}\,(G_{31},t)=\ (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},\ (r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123

They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29}-T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}((G_{31}),t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31})-(G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
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Where we suppose	
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Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\big[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}\big]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} \ , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
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Where we suppose	
(CCCCCCCCC) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i, j = 36,37,38$ (DDDDDDDDD) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39}, t) \leq \ (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
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They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}',t) - (a_i'')^{(7)}(T_{37},t)\rvert \leq (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})',t) - (b_i'')^{(7)}((G_{39}),t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
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Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (GGGGGGGGG) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (HHHHHHHHH) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and\ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)},\ (r_i)^{(7)}, i = 36,37,38,$ satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}\ (\hat{k}_{36})^{(7)}] < 1$	135
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$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
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$(b_i'')^{(8)}((G_{43}),t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
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<u>Definition of</u> $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}$ are positive constants and $i = 40,41,42$	
They satisfy Lipschitz condition:	
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
<u>Definition of</u> $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
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$\frac{1}{(\hat{M}_{40})^{(8)}}[(b_i)^{(8)} + (b_i')^{(8)} + (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}(\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$$(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$$

$$(b_i^{''})^{(9)}(G_{47},t) \leq (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$$

$$\lim_{T_2\to\infty} (a_i^{''})^{(9)}(T_{45},t) = (p_i)^{(9)}$$

$$\lim_{G\to\infty} (b_i^{''})^{(9)}(G_{47},t) = (r_i)^{(9)}$$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$$|(a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}^{'}|e^{-(\hat{M}_{44})^{(9)}t}$$

$$|(b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}((G_{47}),t)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})^{'}||e^{-(\hat{M}_{44})^{(9)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and $(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $\left[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\right]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)} + (a_i^{'})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)} + (b_i^{'})^{(9)} + (\hat{B}_{44})^{(9)} + (\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{13}\right)^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$, $T_i(0) = T_i^0 > 0$	148
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Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{24}\right)^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{28}\right)^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$: $G_i(t) \leq \left(\hat{P}_{32}\right)^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0)\,,T_i(0)$:	153

$G_i(t) \leq \left(\hat{P}_{36}\right)^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{40}\right)^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq \left(\hat{P}_{44}\right)^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a'_{13})^{(1)} + a''_{13})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{15}(t) = T_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \leq (\ \hat{P}_{16}\ )^{(2)}\ , T_i^0 \leq (\ \hat{Q}_{16}\ )^{(2)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{16}\ )^{(2)} e^{(\ \hat{M}_{16}\ )^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{16}\ )^{(2)} e^{(\ \hat{M}_{16}\ )^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}^{'})^{(2)} + a_{16}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \leq (\ \hat{P}_{20}\ )^{(3)}\ , T_i^0 \leq (\ \hat{Q}_{20}\ )^{(3)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{20}\ )^{(3)} e^{(\ \hat{M}_{20}\ )^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{20}\ )^{(3)} e^{(\ \hat{M}_{20}\ )^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}\left(s_{(20)}\right) - \left((a'_{22})^{(3)} + (a''_{22})^{(3)}\left(T_{21}\left(s_{(20)}\right), s_{(20)}\right)\right) G_{22}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b'_{20})^{(3)} - (b''_{20})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{20}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}\left(s_{(20)}\right) - \left((b'_{21})^{(3)} - (b''_{21})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{21}\left(s_{(20)}\right)\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b'_{22})^{(3)} - (b''_{22})^{(3)}\left(G_{23}\left(s_{(20)}\right), s_{(20)}\right)\right) T_{22}\left(s_{(20)}\right)\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}\left(s_{(24)}\right) - \left((a'_{24})^{(4)} + a''_{24})^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{24}\left(s_{(24)}\right)\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}\left(s_{(24)}\right) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{25}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}\left(s_{(24)}\right) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{26}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}\left(s_{(24)}\right) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{24}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}\left(s_{(24)}\right) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{25}\left(s_{(24)}\right)\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}\left(s_{(24)}\right) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)}\left(G_{27}\left(s_{(24)}\right), s_{(24)}\right)\right) T_{26}\left(s_{(24)}\right)\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}^{'})^{(5)} + a_{28}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{32})^{(6)}, T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \le (\ \hat{P}_{36}\ )^{(7)}\ , T_i^0 \le (\ \hat{Q}_{36}\ )^{(7)},$	
$0 \le G_i(t) - G_i^0 \le (\ \hat{P}_{36}\ )^{(7)} e^{(\ \hat{M}_{36}\ )^{(7)} t}$	
$0 \le T_i(t) - T_i^0 \le (\ \hat{Q}_{36}\ )^{(7)} e^{(\ \hat{M}_{36}\ )^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}')^{(7)} + a_{36}'')^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}')^{(7)} + (a_{37}'')^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}')^{(7)} + (a_{38}'')^{(7)} \left(T_{37}(s_{(36)}), s_{(36)} \right) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}')^{(7)} - (b_{36}'')^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}')^{(7)} - (b_{37}'')^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}')^{(7)} - (b_{38}'')^{(7)} \left(G_{39}(s_{(36)}), s_{(36)} \right) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i\ , T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \le (\ \hat{P}_{40}\ )^{(8)}\ , T_i^0 \le (\ \hat{Q}_{40}\ )^{(8)},$	
$0 \le G_i(t) - G_i^0 \le (\ \hat{P}_{40}\ )^{(8)} e^{(\ \hat{M}_{40}\ )^{(8)} t}$	
$0 \le T_i(t) - T_i^0 \le (\ \hat{Q}_{40}\ )^{(8)} e^{(\ \hat{M}_{40}\ )^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}')^{(8)} + a_{40}'')^{(8)} \left(T_{41}(s_{(40)}), s_{(40)} \right) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}')^{(8)} + (a_{41}'')^{(8)} \left(T_{41}(s_{(40)}), s_{(40)} \right) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{42}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{40}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{41}(s_{(40)})\right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43}(s_{(40)}), s_{(40)})\right) T_{42}(s_{(40)})\right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0,\ T_i(0) = T_i^0,\ G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that	168

$(G_{13}(t)-G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)}+G_{14}^0\right)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)}+(\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0+\int_0^t\left[(a_{16})^{(2)}\left(G_{17}^0+(\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right]ds_{(16)}=$ $\left(1+(a_{16})^{(2)}t\right)G_{17}^0+\frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t}-1\right)$	169
From which it follows that $(G_{16}(t)-G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)}+G_{17}^0\right)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)}+(\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0+\int_0^t\left[(a_{20})^{(3)}\left(G_{21}^0+(\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right]ds_{(20)}=$ $\left(1+(a_{20})^{(3)}t\right)G_{21}^0+\frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t}-1\right)$	171
From which it follows that $(G_{20}(t)-G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{P}_{20})^{(3)}+G_{21}^0\right)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)}+(\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for G_{21} , $G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0+\int_0^t\left[(a_{24})^{(4)}\left(G_{25}^0+(\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right]ds_{(24)}=$ $\left(1+(a_{24})^{(4)}t\right)G_{25}^0+\frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t}-1\right)$	173
From which it follows that $(G_{24}(t)-G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)}+G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)}+(\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)}\left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}}\right)\right] ds_{(28)} =$ $\left(1+(a_{28})^{(5)}t\right)G_{29}^0 + \frac{(a_{28})^{(5)}(\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left(e^{(\hat{M}_{28})^{(5)}t}-1\right)$	
From which it follows that $(G_{28}(t)-G_{28}^0)e^{-(\hat{M}_{28})^{(5)}t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}}\left[\left((\hat{P}_{28})^{(5)}+G_{29}^0\right)e^{\left(-\frac{(\hat{P}_{28})^{(5)}+G_{29}^0}{G_{29}^0}\right)} + (\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)}\left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}}\right)\right] ds_{(32)} =$ $\left(1+(a_{32})^{(6)}t\right)G_{33}^0 + \frac{(a_{32})^{(6)}(\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left(e^{(\hat{M}_{32})^{(6)}t}-1\right)$	176
From which it follows that $(G_{32}(t)-G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)}+G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)} + (\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
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From which it follows that $(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)}\left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}}\right)\right] ds_{(40)} =$	180

$\left(1+(a_{40})^{(8)}t\right)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41} , G_{42}, T_{40}, T_{41}, T_{42}	181
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From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t}\leq\frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45} , G_{46}, T_{44}, T_{45}, T_{46}	
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$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)}+\left((\hat{P}_{13})^{(1)}+G_j^0\right)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{13})^{(1)}$	183
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Indeed if we denote

Definition of $\tilde{G}, \tilde{T}$: $\left(\tilde{G}, \tilde{T} \right) = \mathcal{A}^{(1)}(G, T)$

It results

$$\left|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\right| \le \int_0^t (a_{13})^{(1)} \left|G_{14}^{(1)} - G_{14}^{(2)}\right| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} \, ds_{(13)} +$$

$$\int_0^t \{ (a_{13}')^{(1)} \left|G_{13}^{(1)} - G_{13}^{(2)}\right| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} +$$

$$(a_{13}'')^{(1)}\left(T_{14}^{(1)}, s_{(13)}\right)\left|G_{13}^{(1)} - G_{13}^{(2)}\right| e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} +$$

$$G_{13}^{(2)}\left|(a_{13}'')^{(1)}\left(T_{14}^{(1)}, s_{(13)}\right) - (a_{13}'')^{(1)}\left(T_{14}^{(2)}, s_{(13)}\right)\right| \; e^{-(\widehat{M}_{13})^{(1)} s_{(13)}} e^{(\widehat{M}_{13})^{(1)} s_{(13)}} \} ds_{(13)}$$

Where $s_{(13)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses it follows

$$\left|G^{(1)} - G^{(2)}\right| e^{-(\widehat{M}_{13})^{(1)} t} \le \frac{1}{(\widehat{M}_{13})^{(1)}} \left((a_{13})^{(1)} + (a_{13}')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)} \right) d\left(\left(G^{(1)}, T^{(1)}; \; G^{(2)}, T^{(2)} \right) \right)$$ 186

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

<u>Remark 1:</u> The fact that we supposed $(a_{13}'')^{(1)}$ and $(b_{13}'')^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{13})^{(1)} e^{(\widehat{M}_{13})^{(1)} t}$ *and* $(\hat{Q}_{13})^{(1)} e^{(\widehat{M}_{13})^{(1)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(1)}$ and $(b_i'')^{(1)}, i = 13,14,15$ depend only on T_{14} and respectively on $G(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

<u>Remark 2:</u> There does not exist any t where $G_i\,(t) = 0$ *and* $T_i\,(t) = 0$

From 19 to 24 it results

$$G_i\,(t) \ge G_i^0 e^{\left[-\int_0^t \{ (a_i')^{(1)} - (a_i'')^{(1)} (T_{14}(s_{(13)}), s_{(13)}) \} ds_{(13)} \right]} \ge 0$$

$$T_i\,(t) \ge T_i^0 e^{(-(b_i')^{(1)} t)} > 0 \quad \text{for } t > 0$$

<u>Definition of</u> $\left((\widehat{M}_{13})^{(1)} \right)_1, \left((\widehat{M}_{13})^{(1)} \right)_2$ *and* $\left((\widehat{M}_{13})^{(1)} \right)_3$: 187

<u>Remark 3:</u> if G_{13} is bounded, the same property have also G_{14} *and* G_{15} . indeed if

$G_{13} < (\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt} \le \left((\widehat{M}_{13})^{(1)} \right)_1 - (a_{14}')^{(1)} G_{14}$ and by integrating

$$G_{14} \le \left((\widehat{M}_{13})^{(1)} \right)_2 = G_{14}^0 + 2(a_{14})^{(1)} \left((\widehat{M}_{13})^{(1)} \right)_1 / (a_{14}')^{(1)}$$

In the same way , one can obtain $G_{15} \leq \left((\widehat{M}_{13})^{(1)} \right)_3 = G_{15}^0 + 2(a_{15})^{(1)} \left((\widehat{M}_{13})^{(1)} \right)_2 / (a_{15}^{'})^{(1)}$ If G_{14} *or* G_{15} is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.	
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$\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[(\hat{P}_{16})^{(2)} + ((\hat{P}_{16})^{(2)} + G_j^0)e^{-\left(\frac{(\hat{P}_{16})^{(2)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{16})^{(2)}$	191
$\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[((\hat{Q}_{16})^{(2)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{16})^{(2)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{16})^{(2)}\right] \leq (\hat{Q}_{16})^{(2)}$	192
In order that the operator $\mathcal{A}^{(2)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	193
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Indeed if we denote **Definition of** $\widetilde{G_{19}}, \widetilde{T_{19}}$: $\left(\widetilde{G_{19}}, \widetilde{T_{19}} \right) = \mathcal{A}^{(2)}(G_{19}, T_{19})$	195
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Indeed if we denote **Definition of** $\widetilde{G_{23}}, \widetilde{T_{23}}$: $\left(\widetilde{(G_{23})}, \widetilde{(T_{23})} \right) = \mathcal{A}^{(3)}\left((G_{23}), (T_{23}) \right)$	212
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Then $\frac{dT_{21}}{dt} \geq (a_{21})^{(3)}(m)^{(3)} - \varepsilon_3 T_{21}$ which leads to $T_{21} \geq \left(\frac{(a_{21})^{(3)}(m)^{(3)}}{\varepsilon_3}\right)(1-e^{-\varepsilon_3 t}) + T_{21}^0 e^{-\varepsilon_3 t}$ If we take t such that $e^{-\varepsilon_3 t} = \frac{1}{2}$ it results $T_{21} \geq \left(\frac{(a_{21})^{(3)}(m)^{(3)}}{2}\right), \quad t = log\frac{2}{\varepsilon_3}$ By taking now ε_3 sufficiently small one sees that T_{21} is unbounded. The same property holds for T_{22} if $\lim_{t\to\infty}(b_{22}'')^{(3)}\left((G_{23})(t),t\right) = (b_{22}')^{(3)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	220
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$\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}\left[((\hat{Q}_{24})^{(4)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{24})^{(4)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{24})^{(4)}\right] \leq (\hat{Q}_{24})^{(4)}$	223
In order that the operator $\mathcal{A}^{(4)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	224
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Indeed if we denote

Definition of $\widetilde{(G_{27})}, \widetilde{(T_{27})}$: $\left(\widetilde{(G_{27})}, \widetilde{(T_{27})} \right) = \mathcal{A}^{(4)}((G_{27}), (T_{27}))$

It results

$$\left|\tilde{G}_{24}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{24})^{(4)} \left|G_{25}^{(1)} - G_{25}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} ds_{(24)} +$$

$$\int_0^t \{(a'_{24})^{(4)} \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$(a''_{24})^{(4)}(T_{25}^{(1)}, s_{(24)}) \left|G_{24}^{(1)} - G_{24}^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} +$$

$$G_{24}^{(2)} |(a''_{24})^{(4)}(T_{25}^{(1)}, s_{(24)}) - (a''_{24})^{(4)}(T_{25}^{(2)}, s_{(24)})| \; e^{-(\widehat{M}_{24})^{(4)} s_{(24)}} e^{(\widehat{M}_{24})^{(4)} s_{(24)}} \} ds_{(24)}$$

Where $s_{(24)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses on Equations it follows

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$$\left|(G_{27})^{(1)} - (G_{27})^{(2)}\right| e^{-(\widehat{M}_{24})^{(4)} t} \leq$$
$$\frac{1}{(\widehat{M}_{24})^{(4)}} \left((a_{24})^{(4)} + (a'_{24})^{(4)} + (\widehat{A}_{24})^{(4)} + (\widehat{P}_{24})^{(4)} (\widehat{k}_{24})^{(4)} \right) d\left(\left((G_{27})^{(1)}, (T_{27})^{(1)}; (G_{27})^{(2)}, (T_{27})^{(2)} \right) \right)$$

And analogous inequalities for G_i and T_i. Taking into account the hypothesis the result follows

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Remark 16: The fact that we supposed $(a''_{24})^{(4)}$ and $(b''_{24})^{(4)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ and $(\widehat{Q}_{24})^{(4)} e^{(\widehat{M}_{24})^{(4)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(4)}$ and $(b''_i)^{(4)}, i = 24,25,26$ depend only on T_{25} and respectively on (G_{27}) (*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

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Remark 17: There does not exist any t where $G_i(t) = 0$ and $T_i(t) = 0$

it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a'_i)^{(4)} - (a''_i)^{(4)}(T_{25}(s_{(24)}), s_{(24)})\} ds_{(24)} \right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b'_i)^{(4)} t)} > 0 \quad \text{for } t > 0$$

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Definition of $\left((\widehat{M}_{24})^{(4)}\right)_1, \left((\widehat{M}_{24})^{(4)}\right)_2$ and $\left((\widehat{M}_{24})^{(4)}\right)_3$:

Remark 18: if G_{24} is bounded, the same property have also G_{25} and G_{26} . indeed if

$G_{24} < (\widehat{M}_{24})^{(4)}$ it follows $\frac{dG_{25}}{dt} \leq \left((\widehat{M}_{24})^{(4)}\right)_1 - (a'_{25})^{(4)} G_{25}$ and by integrating

$$G_{25} \leq \left((\widehat{M}_{24})^{(4)}\right)_2 = G_{25}^0 + 2(a_{25})^{(4)} \left((\widehat{M}_{24})^{(4)}\right)_1 / (a'_{25})^{(4)}$$

In the same way , one can obtain $G_{26} \leq \left((\widehat{M}_{24})^{(4)} \right)_3 = G_{26}^0 + 2(a_{26})^{(4)} \left((\widehat{M}_{24})^{(4)} \right)_2 / (a_{26}')^{(4)}$ If G_{25} *or* G_{26} is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.	
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The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric $d\left(\left((G_{39})^{(1)},(T_{39})^{(1)}\right),\left((G_{39})^{(2)},(T_{39})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\widehat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\widehat{M}_{36})^{(7)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{39})},\widetilde{(T_{39})}$: $\left(\widetilde{(G_{39})},\widetilde{(T_{39})}\right)=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$ It results $\left\|\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}\right\|\le\int_0^t(a_{36})^{(7)}\left\|G_{37}^{(1)}-G_{37}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\,ds_{(36)}+$ $\int_0^t\{(a_{36}')^{(7)}\left\|G_{36}^{(1)}-G_{36}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}+$ $(a_{36}'')^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)\left\|G_{36}^{(1)}-G_{36}^{(2)}\right\|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}+$ $G_{36}^{(2)}\|(a_{36}'')^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)-(a_{36}'')^{(7)}\left(T_{37}^{(2)},s_{(36)}\right)\|\;e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$ Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses on it follows	258
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$T_i\ (t) \geq T_i^0 e^{\left(-(b_i^{'})^{(7)} t\right)} > 0 \quad \text{for } t > 0$	
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
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it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)}-(a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\}ds_{(40)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i')^{(8)}t)} > 0$ for t > 0	
Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)}G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}')^{(8)}$ If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	276
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$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right) = \sup_i\{\max_{t\in\mathbb{R}_+}|G_i^{(1)}(t) - G_i^{(2)}(t)|e^{-(\hat{M}_{44})^{(9)}t}, \max_{t\in\mathbb{R}_+}|T_i^{(1)}(t) - T_i^{(2)}(t)|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})}, \widetilde{(T_{47})}$: $(\widetilde{(G_{47})}, \widetilde{(T_{47})}) = \mathcal{A}^{(9)}((G_{47}),(T_{47}))$
It results

$$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\hat{M}_{44})^{(9)}s_{(44)}} e^{(\hat{M}_{44})^{(9)}s_{(44)}} ds_{(44)} + \int_0^t \{(a'_{44})^{(9)}|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}} + (a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)})|G_{44}^{(1)} - G_{44}^{(2)}|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}} + G_{44}^{(2)}|(a''_{44})^{(9)}(T_{45}^{(1)}, s_{(44)}) - (a''_{44})^{(9)}(T_{45}^{(2)}, s_{(44)})| \; e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}|e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{1}{(\hat{M}_{44})^{(9)}}((a_{44})^{(9)} + (a'_{44})^{(9)} + (\hat{A}_{44})^{(9)} + (\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)})d\left(((G_{47})^{(1)},(T_{47})^{(1)};\ (G_{47})^{(2)},(T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ *and* $(\hat{Q}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t \to \infty} ((b_i'')^{(9)} ((G_{47})(t), t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log \frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t \to \infty} (b_{46}'')^{(9)} \left((G_{47})(t), t\right) = (b_{46}')^{(9)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying

$-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14}, t) + (a_{14}'')^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b'_{13})^{(1)} + (b'_{14})^{(1)} - (b''_{13})^{(1)}(G,t) - (b''_{14})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}$, $(m_2)^{(1)}$, $(\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}$, $(m_2)^{(1)}$, $(\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)}\ , if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$ and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}\ , if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a'_{15})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}\right] + G_{15}^0 e^{-(a'_{15})^{(1)}t}\right)$	286

$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b'_{15})^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b'_{15})^{(1)}t}\right] + T_{15}^0 e^{-(b'_{15})^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a'_{13})^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b'_{13})^{(1)}$ $(R_2)^{(1)} = (b'_{15})^{(1)} - (r_{15})^{(1)}$	290
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Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}\big((G_{19}), t\big) - (b''_{17})^{(2)}\big((G_{19}), t\big) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\big(u^{(2)}\big)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\big(\nu^{(2)}\big)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\big(u^{(2)}\big)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \ \boldsymbol{if} \ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if} \ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \ \boldsymbol{if} \ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if} \ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}, \ \boldsymbol{if} \ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \le G_{16}(t) \le G_{16}^0 e^{(S_1)^{(2)} t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \le G_{17}(t) \le \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)} t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})} \left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)} t} \right] + G_{18}^0 e^{-(S_2)^{(2)} t} \le G_{18}(t) \le \right.$ $\left. \frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a'_{18})^{(2)})} \left[e^{(S_1)^{(2)} t} - e^{-(a'_{18})^{(2)} t} \right] + G_{18}^0 e^{-(a'_{18})^{(2)} t} \right)$	312
$T_{16}^0 e^{(R_1)^{(2)} t} \le T_{16}(t) \le T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)} t} \le T_{16}(t) \le \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b'_{18})^{(2)})} \left[e^{(R_1)^{(2)} t} - e^{-(b'_{18})^{(2)} t} \right] + T_{18}^0 e^{-(b'_{18})^{(2)} t} \le T_{18}(t) \le$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)} + (r_{16})^{(2)} + (R_2)^{(2)})} \left[e^{((R_1)^{(2)} + (r_{16})^{(2)})t} - e^{-(R_2)^{(2)} t} \right] + T_{18}^0 e^{-(R_2)^{(2)} t}$	315
<u>**Definition of**</u> $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)} (m_2)^{(2)} - (a'_{16})^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}^{'})^{(2)}$ $(R_2)^{(2)} = (b_{18}^{'})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} - (a_{20}^{''})^{(3)}(T_{21}, t) + (a_{21}^{''})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}, t) - (b_{21}^{''})^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\big(\nu^{(3)}\big)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\big(u^{(3)}\big)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)}, \ \boldsymbol{if} \ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}, \boldsymbol{if} \ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}, \ \boldsymbol{if} \ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if} \ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}$, ***if*** $(\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}\big((G_{27}), t\big) - (b_{25}'')^{(4)}\big((G_{27}), t\big) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations	329

$(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0\,, (\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0\,, (\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}\,, (m_2)^{(4)}\,, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}\,, (m_2)^{(4)}\,, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}\,, \boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)},$ and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}\,, \boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)},$ and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)}G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)}-(p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{\left((R_1)^{(4)}+(r_{24})^{(4)}\right)t}$	335
$\frac{(b_{26})^{(4)}T_{24}^0}{(\mu_1)^{(4)}\left((R_1)^{(4)}-(b_{26}')^{(4)}\right)}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$	336

$\frac{(a_{26})^{(4)}T_{24}^{0}}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^{0}e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}^{'})^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}^{'})^{(4)}$ $(R_2)^{(4)}=(b_{26}^{'})^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\le-(a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}-(a_{28}^{''})^{(5)}(T_{29},t)+(a_{29}^{''})^{(5)}(T_{29},t)\le-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\le-(b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(b_{28}^{''})^{(5)}\left((G_{31}),t\right)-(b_{29}^{''})^{(5)}\left((G_{31}),t\right)\le-(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},,(\bar{\nu}_2)^{(5)},(\bar{u}_1)^{(5)},(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)}>0,(\bar{\nu}_2)^{(5)}<0$ and respectively $(\bar{u}_1)^{(5)}>0,(\bar{u}_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar{\nu}_1)^{(5)},\boldsymbol{if}\ (\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^{0}}{G_{29}^{0}}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}\ , \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t} - e^{-(b_{30}')^{(5)}t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)}t}\right] + T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \le -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33},t) + (a''_{33})^{(6)}(T_{33},t) \le -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \le -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}\big((G_{35}),t\big) - (b''_{33})^{(6)}\big((G_{35}),t\big) \le -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}$, $(m_2)^{(6)}$, $(\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}$, $(m_2)^{(6)}$, $(\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},\ \boldsymbol{if}\ (\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}\ , \boldsymbol{if}\ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \le G_{32}(t) \le G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \le G_{33}(t) \le \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \le G_{34}(t) \le\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$$ 356

$$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$$ 357

$$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b'_{34})^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b'_{34})^{(6)}t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)}t} \leq T_{34}(t) \leq$$ 358

$$\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$$

Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- 359

Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a'_{32})^{(6)}$

$(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$

$(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b'_{32})^{(6)}$

$(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$

Behavior of the solutions of equation

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying

$$-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$$

$$-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$$

Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: 361

By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$
and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and

Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: 362

By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$
and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$

Definition of $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:-

If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$ where $(p_i)^{(7)}$ is defined by equation	364
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}] + G_{38}^0 e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0 e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}')^{(7)}$	370

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$ $(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$	
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \le -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \le -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \le -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \le -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
Definition of $(\bar{\nu}_1)^{(8)}, , (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0, (\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0, (\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}, \; \boldsymbol{if} \; (\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}, \boldsymbol{if} \; (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	

and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}\ , \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)}-(p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)}-(a'_{42})^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a'_{42})^{(8)}t}\right] + G_{42}^0 e^{-(a'_{42})^{(8)}t}\right)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
<u>**Behavior of the solutions of equation 37 to 92**</u> <u>**Theorem 2:**</u> If we denote and define	382

Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$

$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\left((G_{47}), t\right) - (b''_{45})^{(9)}\left((G_{47}), t\right) \leq -(\tau_1)^{(9)}$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \; \boldsymbol{if} \; (\nu_0)^{(9)} < (\nu_1)^{(9)}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \; (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \; \boldsymbol{if} \; (u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \; (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \; (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$

where $(p_i)^{(9)}$ is defined by equation 45

$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$

$$\left(\frac{(a_{46})^{(9)}G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})}\left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t}-e^{-(S_2)^{(9)}t}\right]+G_{46}^0e^{-(S_2)^{(9)}t}\le G_{46}(t)\le \frac{(a_{46})^{(9)}G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})}\left[e^{(S_1)^{(9)}t}-e^{-(a_{46}')^{(9)}t}\right]+G_{46}^0e^{-(a_{46}')^{(9)}t}\right)$$

$$\boxed{T_{44}^0e^{(R_1)^{(9)}t}\le T_{44}(t)\le T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$$

$$\frac{1}{(\mu_1)^{(9)}}T_{44}^0e^{(R_1)^{(9)}t}\le T_{44}(t)\le\frac{1}{(\mu_2)^{(9)}}T_{44}^0e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)}T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})}\left[e^{(R_1)^{(9)}t}-e^{-(b_{46}')^{(9)}t}\right]+T_{46}^0e^{-(b_{46}')^{(9)}t}\le T_{46}(t)\le$$

$$\frac{(a_{46})^{(9)}T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})}\left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t}-e^{-(R_2)^{(9)}t}\right]+T_{46}^0e^{-(R_2)^{(9)}t}$$

Definition of $(S_1)^{(9)},(S_2)^{(9)},(R_1)^{(9)},(R_2)^{(9)}$:-

Where $(S_1)^{(9)}=(a_{44})^{(9)}(m_2)^{(9)}-(a_{44}')^{(9)}$

$(S_2)^{(9)}=(a_{46})^{(9)}-(p_{46})^{(9)}$

$(R_1)^{(9)}=(b_{44})^{(9)}(\mu_2)^{(9)}-(b_{44}')^{(9)}$

$(R_2)^{(9)}=(b_{46}')^{(9)}-(r_{46})^{(9)}$

Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right) - (a_{14}^{''})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \leq \frac{d\nu^{(1)}}{dt} \leq -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \geq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \leq \nu^{(1)}(t) \leq (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \leq \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \leq \nu^{(1)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \leq (\bar{\nu}_1)^{(1)} \leq \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \leq \nu^{(1)}(t) \leq \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \leq (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have	386

Definition of $\nu^{(1)}(t)$:- $(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}$, $\boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(1)}(t)$:- $(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}$, $\boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. Particular case : If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then $(u_1)^{(1)} = (\bar{u}_1)^{(1)}$ if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.	
Proof : From global equations we obtain $\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right) - (a''_{17})^{(2)}(T_{17},t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$	387
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From which one obtains **Definition of** $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:- For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$ $\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}$, $\boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$ it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$	390
In the same manner , we get	391

$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
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In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
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$\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a_{20}')^{(3)} - (a_{21}')^{(3)} + (a_{20}'')^{(3)}(T_{21},t)\right) - (a_{21}'')^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)} e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(3)}(t)$:-	403

$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .**

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

Proof : From global equations we obtain 408

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains **Definition of** $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:- For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$ $\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}$, $\boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$ it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$	
In the same manner , we get $\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}$, $\boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$ From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$	409
If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, $(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$	410
If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain $(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(5)}(t)$:- $(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}$, $\boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(5)}(t)$:- $(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$	411

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$**, and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \le \nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **<u>Definition of</u>** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
<u>Definition of</u> $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **<u>Particular case :</u>** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:-	424

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$

$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$,

$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$

$with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with\ (p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}^{'})^{(9)}(b_{45}^{'})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}^{'})^{(9)}(r_{45})^{(9)} - (b_{45}^{'})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - [(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - [(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - [(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - [(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - [(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - [(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - [(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - [(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - [(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - [(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - [(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25})]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - [(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25})]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (jj) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) +$	486

$(a''_{16})^{(2)}(T_{17})(a''_{17})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a'_{20})^{(3)}(a'_{21})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a'_{20})^{(3)}(a''_{21})^{(3)}(T_{21}) + (a'_{21})^{(3)}(a''_{20})^{(3)}(T_{21}) + (a''_{20})^{(3)}(T_{21})(a''_{21})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a'_{24})^{(4)}(a'_{25})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a'_{24})^{(4)}(a''_{25})^{(4)}(T_{25}) + (a'_{25})^{(4)}(a''_{24})^{(4)}(T_{25}) + (a''_{24})^{(4)}(T_{25})(a''_{25})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a'_{28})^{(5)}(a'_{29})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a'_{28})^{(5)}(a''_{29})^{(5)}(T_{29}) + (a'_{29})^{(5)}(a''_{28})^{(5)}(T_{29}) + (a''_{28})^{(5)}(T_{29})(a''_{29})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a'_{32})^{(6)}(a'_{33})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a'_{32})^{(6)}(a''_{33})^{(6)}(T_{33}) + (a'_{33})^{(6)}(a''_{32})^{(6)}(T_{33}) + (a''_{32})^{(6)}(T_{33})(a''_{33})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a'_{44})^{(9)}(a'_{45})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a'_{44})^{(9)}(a''_{45})^{(9)}(T_{45}) + (a'_{45})^{(9)}(a''_{44})^{(9)}(T_{45}) + (a''_{44})^{(9)}(T_{45})(a''_{45})^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^{*} :- 493

After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^{*} for which $f(T_{14}^{*})=0$. With this value , we obtain from the three first equations

$$G_{13}=\frac{(a_{13})^{(1)}G_{14}}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^{*})]} \quad , \quad G_{15}=\frac{(a_{15})^{(1)}G_{14}}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^{*})]}$$

Definition and uniqueness of T_{17}^{*} :- 494

After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^{*} for which $f(T_{17}^{*})=0$. With this value , we obtain from the three first equations

$$G_{16}=\frac{(a_{16})^{(2)}G_{17}}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^{*})]} \quad , \quad G_{18}=\frac{(a_{18})^{(2)}G_{17}}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^{*})]} \qquad 495$$

Definition and uniqueness of T_{21}^{*} :- 496

After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*})=0$. With this value , we obtain from the three first equations

$$G_{20}=\frac{(a_{20})^{(3)}G_{21}}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^{*})]} \quad , \quad G_{22}=\frac{(a_{22})^{(3)}G_{21}}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^{*})]}$$

Definition and uniqueness of T_{25}^{*} :- 497

After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*})=0$. With this value , we obtain from the three first equations

$$G_{24}=\frac{(a_{24})^{(4)}G_{25}}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^{*})]} \quad , \quad G_{26}=\frac{(a_{26})^{(4)}G_{25}}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^{*})]}$$

Definition and uniqueness of T_{29}^{*} :- 498

After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*})=0$. With this value , we obtain from the three first equations

$$G_{28}=\frac{(a_{28})^{(5)}G_{29}}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^{*})]} \quad , \quad G_{30}=\frac{(a_{30})^{(5)}G_{29}}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^{*})]}$$

Definition and uniqueness of T_{33}^{*} :- 499

After hypothesis $f(0)<0, f(\infty)>0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*})=0$. With this value , we obtain from the three first equations

$G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}^{'})^{(8)}+(a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right]+(b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right]+(b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}^{'})^{(3)}(b_{21}^{''})^{(3)}(G_{23}) + (b_{21}^{'})^{(3)}(b_{20}^{''})^{(3)}(G_{23})\right]+(b_{20}^{''})^{(3)}(G_{23})(b_{21}^{''})^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}^{'})^{(4)}(b_{25}^{''})^{(4)}(G_{27}) + (b_{25}^{'})^{(4)}(b_{24}^{''})^{(4)}(G_{27})\right]+(b_{24}^{''})^{(4)}(G_{27})(b_{25}^{''})^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*}) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}^{'})^{(5)}(b_{29}^{''})^{(5)}(G_{31}) + (b_{29}^{'})^{(5)}(b_{28}^{''})^{(5)}(G_{31})\right]+(b_{28}^{''})^{(5)}(G_{31})(b_{29}^{''})^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*}) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}^{'})^{(6)}(b_{33}^{''})^{(6)}(G_{35}) + (b_{33}^{'})^{(6)}(b_{32}^{''})^{(6)}(G_{35})\right]+(b_{32}^{''})^{(6)}(G_{35})(b_{33}^{''})^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*}) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39}) + (b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right]+(b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*}) = 0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right]+(b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42})$, G_{40}, G_{42} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right]+(b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46})$, G_{44}, G_{46} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$	523

$T_{40}^{*}=\frac{(b_{40})^{(8)}T_{41}^{*}}{[(b_{40}^{'})^{(8)}-(b_{40}^{''})^{(8)}((G_{43})^{*})]}$, $T_{42}^{*}=\frac{(b_{42})^{(8)}T_{41}^{*}}{[(b_{42}^{'})^{(8)}-(b_{42}^{''})^{(8)}((G_{43})^{*})]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^{*} given by $\varphi((G_{47})^{*})=0$, T_{45}^{*} given by $f(T_{45}^{*})=0$ and $G_{44}^{*}=\frac{(a_{44})^{(9)}G_{45}^{*}}{[(a_{44}^{'})^{(9)}+(a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46}^{*}=\frac{(a_{46})^{(9)}G_{45}^{*}}{[(a_{46}^{'})^{(9)}+(a_{46}^{''})^{(9)}(T_{45}^{*})]}$ $T_{44}^{*}=\frac{(b_{44})^{(9)}T_{45}^{*}}{[(b_{44}^{'})^{(9)}-(b_{44}^{''})^{(9)}((G_{47})^{*})]}$, $T_{46}^{*}=\frac{(b_{46})^{(9)}T_{45}^{*}}{[(b_{46}^{'})^{(9)}-(b_{46}^{''})^{(9)}((G_{47})^{*})]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote <u>**Definition of**</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i$, $T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^{*})=(q_{14})^{(1)}$, $\frac{\partial(b_i^{''})^{(1)}}{\partial G_j}(G^{*})=s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt}=-\left((a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\mathbb{G}_{13}+(a_{13})^{(1)}\mathbb{G}_{14}-(q_{13})^{(1)}G_{13}^{*}\mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt}=-\left((a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)\mathbb{G}_{14}+(a_{14})^{(1)}\mathbb{G}_{13}-(q_{14})^{(1)}G_{14}^{*}\mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt}=-\left((a_{15}^{'})^{(1)}+(p_{15})^{(1)}\right)\mathbb{G}_{15}+(a_{15})^{(1)}\mathbb{G}_{14}-(q_{15})^{(1)}G_{15}^{*}\mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt}=-\left((b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)\mathbb{T}_{13}+(b_{13})^{(1)}\mathbb{T}_{14}+\sum_{j=13}^{15}\left(s_{(13)(j)}T_{13}^{*}\mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt}=-\left((b_{14}^{'})^{(1)}-(r_{14})^{(1)}\right)\mathbb{T}_{14}+(b_{14})^{(1)}\mathbb{T}_{13}+\sum_{j=13}^{15}\left(s_{(14)(j)}T_{14}^{*}\mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt}=-\left((b_{15}^{'})^{(1)}-(r_{15})^{(1)}\right)\mathbb{T}_{15}+(b_{15})^{(1)}\mathbb{T}_{14}+\sum_{j=13}^{15}\left(s_{(15)(j)}T_{15}^{*}\mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS <u>**Theorem 4:**</u> If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i'')^{(2)}$ and $(b_i'')^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}'')^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i'')^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}')^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}')^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}')^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}')^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}')^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}')^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(3)}$ *and* $(b_i'')^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}'')^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i'')^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}')^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}')^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}')^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}')^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^*) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ *and* $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}((G_{31})^*) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^{*}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^{*}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^{*}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^{*}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}^{'})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^{*}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^{*}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ *and* $(b_i^{''})^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{33}^{''})^{(6)}}{\partial T_{33}}(T_{33}^{*}) = (q_{33})^{(6)} \quad , \frac{\partial (b_i^{''})^{(6)}}{\partial G_j}(\,(G_{35})^{*}\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}^{'})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^{*}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}^{'})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^{*}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}^{'})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^{*}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}^{'})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^{*}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}^{'})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^{*}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}^{'})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^{*}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}$ *and* $(b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{37})^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b''_i)^{(7)}}{\partial G_j}(\,(G_{39})^{**}\,) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a'_{36})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a'_{37})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(8)}$ *and* $(b''_i)^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{41})^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b''_i)^{(8)}}{\partial G_j}(\,(G_{43})^*\,) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a'_{40})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a'_{41})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt}=-\left((b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)\mathbb{T}_{40}+(b_{40})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt}=-\left((b_{41}^{'})^{(8)}-(r_{41})^{(8)}\right)\mathbb{T}_{41}+(b_{41})^{(8)}\mathbb{T}_{40}+\sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt}=-\left((b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\mathbb{T}_{42}+(b_{42})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad , T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial (a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*})=(q_{45})^{(9)} \quad , \frac{\partial (b_i^{''})^{(9)}}{\partial G_j}\left((G_{47})^{*}\right)=s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt}=-\left((a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\mathbb{G}_{44}+(a_{44})^{(9)}\mathbb{G}_{45}-(q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt}=-\left((a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)\mathbb{G}_{45}+(a_{45})^{(9)}\mathbb{G}_{44}-(q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt}=-\left((a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)\mathbb{G}_{46}+(a_{46})^{(9)}\mathbb{G}_{45}-(q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt}=-\left((b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)\mathbb{T}_{44}+(b_{44})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt}=-\left((b_{45}^{'})^{(9)}-(r_{45})^{(9)}\right)\mathbb{T}_{45}+(b_{45})^{(9)}\mathbb{T}_{44}+\sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt}=-\left((b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\mathbb{T}_{46}+(b_{46})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)}+(b_{15}^{'})^{(1)}-(r_{15})^{(1)}\right)\{\left((\lambda)^{(1)}+(a_{15}^{'})^{(1)}+(p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+\left((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$$

$+$

$$\left((\lambda)^{(2)} + (b_{18}')^{(2)} - (r_{18})^{(2)}\right)\{\left((\lambda)^{(2)} + (a_{18}')^{(2)} + (p_{18})^{(2)}\right)$$

$$\left[\left(\left((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^* + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)\right]$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^*\right)$$

$$+\left(\left((\lambda)^{(2)} + (a_{17}')^{(2)} + (p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^* + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^*\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^*\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}')^{(2)} + (b_{17}')^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^* + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)$$

$$\left(\left((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^*\right)\} = 0$$

$+$

$$\left((\lambda)^{(3)} + (b_{22}')^{(3)} - (r_{22})^{(3)}\right)\{\left((\lambda)^{(3)} + (a_{22}')^{(3)} + (p_{22})^{(3)}\right)$$

$$\left[\left(\left((\lambda)^{(3)} + (a_{20}')^{(3)} + (p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^* + (a_{21})^{(3)}(q_{20})^{(3)}G_{20}^*\right)\right]$$

$$\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^* + (b_{21})^{(3)}s_{(20),(21)}T_{21}^*\right)$$

$$+\left(\left((\lambda)^{(3)} + (a_{21}')^{(3)} + (p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^* + (a_{20})^{(3)}(q_{21})^{(1)}G_{21}^*\right)$$

$$\left(\left((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^* + (b_{21})^{(3)}s_{(20),(20)}T_{20}^*\right)$$

$\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2 + \left((b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)})s_{(21),(22)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\} = 0$ +	
$((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)})\{((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)})$ $\left[\left(((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)})(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)})s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)})\{((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)})$ $\left[\left(((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)})(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)})(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)})s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((b'_{28})^{(5)} + (b'_{29})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right) (q_{30})^{(5)} G_{30}$$

$$+\left((\lambda)^{(5)} + (a'_{28})^{(5)} + (p_{28})^{(5)}\right) \left((a_{30})^{(5)}(q_{29})^{(5)} G^*_{29} + (a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)} G^*_{28}\right)$$

$$\left(\left((\lambda)^{(5)} + (b'_{28})^{(5)} - (r_{28})^{(5)}\right) s_{(29),(30)} T^*_{29} + (b_{29})^{(5)} s_{(28),(30)} T^*_{28}\right)\} = 0$$

+

$$\left((\lambda)^{(6)} + (b'_{34})^{(6)} - (r_{34})^{(6)}\right)\{\left((\lambda)^{(6)} + (a'_{34})^{(6)} + (p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)}\right)(q_{33})^{(6)} G^*_{33} + (a_{33})^{(6)}(q_{32})^{(6)} G^*_{32}\right)\right]$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(33)} T^*_{33} + (b_{33})^{(6)} s_{(32),(33)} T^*_{33}\right)$$

$$+\left(\left((\lambda)^{(6)} + (a'_{33})^{(6)} + (p_{33})^{(6)}\right)(q_{32})^{(6)} G^*_{32} + (a_{32})^{(6)}(q_{33})^{(6)} G^*_{33}\right)$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(32)} T^*_{33} + (b_{33})^{(6)} s_{(32),(32)} T^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((b'_{32})^{(6)} + (b'_{33})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right) (q_{34})^{(6)} G_{34}$$

$$+\left((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)}\right) \left((a_{34})^{(6)}(q_{33})^{(6)} G^*_{33} + (a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)} G^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(34)} T^*_{33} + (b_{33})^{(6)} s_{(32),(34)} T^*_{32}\right)\} = 0$$

+

$$\left((\lambda)^{(7)} + (b'_{38})^{(7)} - (r_{38})^{(7)}\right)\{\left((\lambda)^{(7)} + (a'_{38})^{(7)} + (p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)} + (a'_{36})^{(7)} + (p_{36})^{(7)}\right)(q_{37})^{(7)} G^*_{37} + (a_{37})^{(7)}(q_{36})^{(7)} G^*_{36}\right)\right]$$

$$\left(\left((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(37)} T^*_{37} + (b_{37})^{(7)} s_{(36),(37)} T^*_{37}\right)$$

$$+\left(\left((\lambda)^{(7)} + (a'_{37})^{(7)} + (p_{37})^{(7)}\right)(q_{36})^{(7)} G^*_{36} + (a_{36})^{(7)}(q_{37})^{(7)} G^*_{37}\right)$$

$$\left(\left((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(36)} T^*_{37} + (b_{37})^{(7)} s_{(36),(36)} T^*_{36}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2 + \left((b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (r_{36})^{(7)} + (r_{37})^{(7)}\right) (\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2 + \left((a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} + (p_{36})^{(7)} + (p_{37})^{(7)}\right) (\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+((\lambda)^{(7)} + (a_{36}^{'})^{(7)} + (p_{36})^{(7)})\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*} + (a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$$

$$\left(((\lambda)^{(7)} + (b_{36}^{'})^{(7)} - (r_{36})^{(7)})s_{(37),(38)}T_{37}^{*} + (b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(8)} + (b_{42}^{'})^{(8)} - (r_{42})^{(8)})\{((\lambda)^{(8)} + (a_{42}^{'})^{(8)} + (p_{42})^{(8)})$$

$$\left[\left(((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(41)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$$

$$+\left(((\lambda)^{(8)} + (a_{41}^{'})^{(8)} + (p_{41})^{(8)})(q_{40})^{(8)}G_{40}^{*} + (a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(40)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2 + \left((b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (r_{40})^{(8)} + (r_{41})^{(8)}\right) (\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2 + \left((a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} + (p_{40})^{(8)} + (p_{41})^{(8)}\right) (\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+((\lambda)^{(8)} + (a_{40}^{'})^{(8)} + (p_{40})^{(8)})\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*} + (a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$$

$$\left(((\lambda)^{(8)} + (b_{40}^{'})^{(8)} - (r_{40})^{(8)})s_{(41),(42)}T_{41}^{*} + (b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\} = 0$$

$+$

$$((\lambda)^{(9)} + (b_{46}^{'})^{(9)} - (r_{46})^{(9)})\{((\lambda)^{(9)} + (a_{46}^{'})^{(9)} + (p_{46})^{(9)})$$

$$\left[\left(((\lambda)^{(9)} + (a_{44}^{'})^{(9)} + (p_{44})^{(9)})(q_{45})^{(9)}G_{45}^{*} + (a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$$

$$\left(((\lambda)^{(9)} + (b_{44}^{'})^{(9)} - (r_{44})^{(9)})s_{(45),(45)}T_{45}^{*} + (b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$$

$$+\left(((\lambda)^{(9)} + (a_{45}^{'})^{(9)} + (p_{45})^{(9)})(q_{44})^{(9)}G_{44}^{*} + (a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$$

$$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$$

$$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$$

$$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION THIRTY SIX

New LHC Benchmarks For The CP-Conserving Two-Higgs-Doublet Model

INTRODUCTION—VARIABLES USED

New LHC Benchmarks for the CP-conserving Two-Higgs-Doublet Model Howard E. Haber, Oscar Stal

(1) Authors introduce a strategy to study the parameter space of (e) the general, CP-conserving, two-Higgs-doublet Model (2HDM) with (e&eb) a softly broken Z_2-symmetry by means of (e) a new "hybrid" basis.

(2) In this basis the input parameters are (=) the measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength to (e&eb) vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters.

(3) Using the hybrid basis, authors present numerical scans of the 2HDM parameter space where (e) authors survey available parameter regions and analyze model constraints.

(4) From these results, authors define a number of benchmark scenarios that capture (e) different aspects of non-standard Higgs phenomenology that are of interest for future LHC Higgs searches. Subjects: High Energy Physics - Phenomenology (hep-ph); High Energy Physics - Experiment (hep-ex) Report number: SCIPP-15/10 Cite as: arXiv:1507.04281 [hep-ph] (or

arXiv:1507.04281v3 [hep-ph] for this version)	
NOTATION	
Module One Moreover, the alignment limit in the NMSSM leads to a well defined spectrum in (eb) the Higgs and Higgsino sectors, and yields (eb) a rich and interesting Higgs boson phenomenology that can be tested at the LHC	
G_{13} : Category one of alignment limit in the NMSSM leads to a well defined spectrum in the Higgs and Higgsino sectors, G_{14} : Category two of G_{15} : Category three of	
T_{13} : Category one of rich and interesting Higgs boson phenomenology that can be tested at the LHC T_{14} : Category two of T_{15} : Category three of	
Module Two Authors introduce a strategy to study the parameter space of (e) the general, CP-conserving, two-Higgs-doublet Model (2HDM) with (e&eb) a softly broken Z_2-symmetry by means of (e) a new "hybrid" basis	
G_{16} : Category one of general, CP-conserving, two-Higgs-doublet Model (2HDM) with (e&eb) a softly broken Z_2-symmetry by means of (e) a new "hybrid" basis G_{17} : Category two of G_{18} : Category three of	
T_{16} : Category one of parameter space T_{17} : Category two of T_{18} : Category three of	
Module three Authors introduce a strategy to study the parameter space of the general, CP-conserving, two-Higgs-doublet Model (2HDM) with (e&eb) a softly broken Z_2-symmetry by means of (e) a new "hybrid" basis	
G_{20} : Category one of **parameter space of the general, CP-conserving, two-Higgs-doublet Model (2HDM);** softly broken Z_2-symmetry by means of (e) a new "hybrid" basis G_{21} : Category two of G_{22} : Category three of	
T_{20} : Category one of softly broken Z_2-symmetry by means of (e) a new "hybrid" basis; **parameter space of the general, CP-conserving, two-Higgs-doublet Model (2HDM)** T_{21} : Category two of	

T_{22} : Category three of	
Module four Authors introduce a strategy to study the parameter space of the general, CP-conserving, two-Higgs-doublet Model (2HDM) with a softly broken Z_2-symmetry by means of (e) a new "hybrid" basis	
G_{24} : Category one of **parameter space of the general, CP-conserving, two-Higgs-doublet Model (2HDM) with a softly broken Z_2-symmetry;** new "hybrid" basis G_{25} : Category two of G_{26} : Category three of	
T_{24} : Category one of new "hybrid" basis; **parameter space of the general, CP-conserving, two-Higgs-doublet Model (2HDM) with a softly broken Z_2-symmetry** T_{25} : Category two of T_{26} : Category three of	
Module five In this basis the input parameters are (=) the measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength to (e&eb) vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters.	
G_{28} : Category one of **measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength;** vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters. G_{29} : Category two of G_{30} : Category three of	
T_{28} : Category one of vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters.;**measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength** T_{29} : Category two of T_{30} : Category three of	
Module six In this basis the input parameters are (=) the measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength to (e&eb) vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters	

G_{32} : Category one of **measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength;** mass of the second CP-even Higgs boson, G_{33} : Category two of G_{34} : Category three of	
T_{32} : Category one of mass of the second CP-even Higgs boson,;**measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength** T_{33} : Category two of T_{34} : Category three of	
Module seven In this basis the input parameters are (=) the measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength to (e&eb) vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters	
G_{36} : Category one of **measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength;** mass of the second CP-even Higgs boson G_{37} : Category two of G_{38} : Category three of	
T_{36} : Category one of mass of the second CP-even Higgs boson **;measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength** T_{37} : Category two of T_{38} : Category three of	
Module eight In this basis the input parameters are (=) the measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength to (e&eb) vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters	
G_{40} : Category one of **measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength;** ratio of neutral Higgs vacuum expectation values G_{41} : Category two of G_{42} : Category three of	

T_{40} : Category one of ratio of neutral Higgs vacuum expectation values **;measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength** T_{41} : Category two of T_{42} : Category three of	
Module Nine In this basis the input parameters are (=) the measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength to (e&eb) vector boson pairs, (e&eb) the mass of the second CP-even Higgs boson, (e @êb)the ratio of neutral Higgs vacuum expectation values, and (e&eb) three additional dimensionless parameters	
G_{44} : Category one of **measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength;** three additional dimensionless parameters G_{45} : Category two of G_{46} : Category three of	
T_{44} : Category one of three additional dimensionless parameters **;measured values of the mass of the observed Standard Model (SM)-like Higgs boson and its coupling strength** T_{45} : Category two of T_{46} : Category three of	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$ $(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}, (b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$ $(a_{40})^{(8)}, (a_{41})^{(8)}, (a_{42})^{(8)}, (b_{40})^{(8)}, (b_{41})^{(8)}, (b_{42})^{(8)}$ $(a_{44})^{(9)}, (a_{45})^{(9)}, (a_{46})^{(9)}, (b_{44})^{(9)}, (b_{45})^{(9)}, (b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)}, (a'_{14})^{(1)}, (a'_{15})^{(1)}, (b'_{13})^{(1)}, (b'_{14})^{(1)}, (b'_{15})^{(1)}, (a'_{16})^{(2)}, (a'_{17})^{(2)}, (a'_{18})^{(2)}$, $(b'_{16})^{(2)}, (b'_{17})^{(2)}, (b'_{18})^{(2)}$, $(a'_{20})^{(3)}, (a'_{21})^{(3)}, (a'_{22})^{(3)}, (b'_{20})^{(3)}, (b'_{21})^{(3)}, (b'_{22})^{(3)}$ $(a'_{24})^{(4)}, (a'_{25})^{(4)}, (a'_{26})^{(4)}, (b'_{24})^{(4)}, (b'_{25})^{(4)}, (b'_{26})^{(4)}, (b'_{28})^{(5)}, (b'_{29})^{(5)}, (b'_{30})^{(5)}$ $(a'_{28})^{(5)}, (a'_{29})^{(5)}, (a'_{30})^{(5)}$, $(a'_{32})^{(6)}, (a'_{33})^{(6)}, (a'_{34})^{(6)}, (b'_{32})^{(6)}, (b'_{33})^{(6)}, (b'_{34})^{(6)}$ $(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}, (b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$, $(a'_{40})^{(8)}, (a'_{41})^{(8)}, (a'_{42})^{(8)}, (b'_{40})^{(8)}, (b'_{41})^{(8)}, (b'_{42})^{(8)}$, $(a'_{44})^{(9)}, (a'_{45})^{(9)}, (a'_{46})^{(9)}, (b'_{44})^{(9)}, (b'_{45})^{(9)}, (b'_{46})^{(9)}$, are Dissipation coefficients	

Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b'_{13})^{(1)} - (b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b'_{14})^{(1)} - (b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b'_{15})^{(1)} - (b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t) =$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t) =$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b'_{16})^{(2)} - (b''_{16})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b'_{17})^{(2)} - (b''_{17})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b'_{18})^{(2)} - (b''_{18})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t) =$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}),t\right) =$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right]G_{20}$	13
$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a''_{20})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b''_{20})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right]G_{24}$	19

$\frac{dG_{25}}{dt}=(a_{25})^{(4)}G_{24}-\left[(a_{25}^{'})^{(4)}+(a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt}=(a_{26})^{(4)}G_{25}-\left[(a_{26}^{'})^{(4)}+(a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[(b_{24}^{'})^{(4)}-(b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\left[(b_{25}^{'})^{(4)}-(b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt}=(b_{26})^{(4)}T_{25}-\left[(b_{26}^{'})^{(4)}-(b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t)=$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right)=$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\left[(a_{28}^{'})^{(5)}+(a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\left[(a_{29}^{'})^{(5)}+(a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt}=(a_{30})^{(5)}G_{29}-\left[(a_{30}^{'})^{(5)}+(a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt}=(b_{28})^{(5)}T_{29}-\left[(b_{28}^{'})^{(5)}-(b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt}=(b_{29})^{(5)}T_{28}-\left[(b_{29}^{'})^{(5)}-(b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt}=(b_{30})^{(5)}T_{29}-\left[(b_{30}^{'})^{(5)}-(b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t)=$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}),t\right)=$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[(a_{32}^{'})^{(6)}+(a_{32}^{''})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\left[(a_{33}^{'})^{(6)}+(a_{33}^{''})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\left[(a_{34}^{'})^{(6)}+(a_{34}^{''})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\left[(b_{32}^{'})^{(6)}-(b_{32}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt}=(b_{33})^{(6)}T_{32}-\left[(b_{33}^{'})^{(6)}-(b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35
$\frac{dT_{34}}{dt}=(b_{34})^{(6)}T_{33}-\left[(b_{34}^{'})^{(6)}-(b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t)=$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt}=(a_{36})^{(7)}G_{37}-\left[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt}=(a_{37})^{(7)}G_{36}-\left[(a_{37}^{'})^{(7)}+(a_{37}^{''})^{(7)}(T_{37},t)\right]G_{37}$	*38*
$\frac{dG_{38}}{dt}=(a_{38})^{(7)}G_{37}-\left[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37},t)\right]G_{38}$	*39*
$\frac{dT_{36}}{dt}=(b_{36})^{(7)}T_{37}-\left[(b_{36}^{'})^{(7)}-(b_{36}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	*40*
$\frac{dT_{37}}{dt}=(b_{37})^{(7)}T_{36}-\left[(b_{37}^{'})^{(7)}-(b_{37}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	*41*

$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	42
$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b'_{44})^{(9)} - (b''_{44})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b'_{45})^{(9)} - (b''_{45})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b'_{46})^{(9)} - (b''_{46})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a''_{44})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b''_{44})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[\begin{matrix}(a'_{13})^{(1)} \boxed{+(a''_{13})^{(1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{13}$	55
$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[\begin{matrix}(a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{14}$	56
$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[\begin{matrix}(a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{15}$	57
Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3	

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3 $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$,$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\begin{bmatrix}(b'_{13})^{(1)}\boxed{-(b''_{13})^{(1)}(G,t)}\ \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{13}$	58
$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\begin{bmatrix}(b'_{14})^{(1)}\boxed{-(b''_{14})^{(1)}(G,t)}\ \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{14}$	59
$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\begin{bmatrix}(b'_{15})^{(1)}\boxed{-(b''_{15})^{(1)}(G,t)}\ \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}\\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8)}(G_{43},t)}\ \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{15}$	*60*
Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$,$\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[\begin{matrix}(a'_{16})^{(2)}\boxed{+(a''_{16})^{(2)}(T_{17},t)}\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{16} \quad 61$$

$$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[\begin{matrix}(a'_{17})^{(2)}\boxed{+(a''_{17})^{(2)}(T_{17},t)}\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{17} \quad 62$$

$$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[\begin{matrix}(a'_{18})^{(2)}\boxed{+(a''_{18})^{(2)}(T_{17},t)}\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}\end{matrix}\right]G_{18} \quad 63$$

Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)}$ are eight augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9)}(T_{45},t)}$ are ninth augmentation coefficient for category 1, 2 and 3

$$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[\begin{matrix}(b'_{16})^{(2)}\boxed{-(b''_{16})^{(2)}(G_{19},t)}\boxed{-(b''_{13})^{(1,1,)}(G,t)}\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{16} \quad 64$$

$$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[\begin{matrix}(b'_{17})^{(2)}\boxed{-(b''_{17})^{(2)}(G_{19},t)}\boxed{-(b''_{14})^{(1,1,)}(G,t)}\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}\end{matrix}\right]T_{17} \quad 65$$

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \begin{bmatrix} (b'_{18})^{(2)} \boxed{-(b''_{18})^{(2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,)}(G,t)} \boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9)}(G_{47},t)} \end{bmatrix} T_{18}$$ 66

where $\boxed{-(b''_{16})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2)}(G_{19},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,)}(G,t)}$ are second detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{20})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{36})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{40})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1,2 and 3

$\boxed{-(b''_{44})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2 and 3

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \begin{bmatrix} (a'_{20})^{(3)} \boxed{+(a''_{20})^{(3)}(T_{21},t)} \boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{20}$$ 67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21}$$ 68

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22}$$ 69

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$+(a_{24}'')^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a_{25}'')^{(4,4,4,4,4,4)}(T_{25},t)$, $+(a_{26}'')^{(4,4,4,4,4,4)}(T_{25},t)$ are fourth augmentation coefficients for category 1, 2 and 3 $+(a_{28}'')^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a_{29}'')^{(5,5,5,5,5,5)}(T_{29},t)$, $+(a_{30}'')^{(5,5,5,5,5,5)}(T_{29},t)$ are fifth augmentation coefficients for category 1, 2 and 3 $+(a_{32}'')^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a_{33}'')^{(6,6,6,6,6,6)}(T_{33},t)$, $+(a_{34}'')^{(6,6,6,6,6,6)}(T_{33},t)$ are sixth augmentation coefficients for category 1, 2 and 3 $+(a_{36}'')^{(7,7,7,7)}(T_{37},t)$, $+(a_{37}'')^{(7,7,7,7)}(T_{37},t)$, $+(a_{38}'')^{(7,7,7,7)}(T_{37},t)$ are seventh augmentation coefficients for category 1, 2 and 3 $+(a_{40}'')^{(8,8,8,8)}(T_{41},t)$, $+(a_{41}'')^{(8,8,8,8)}(T_{41},t)$, $+(a_{42}'')^{(8,8,8,8)}(T_{41},t)$ are eight augmentation coefficients for category 1, 2 and 3 $+(a_{44}'')^{(9,9,9)}(T_{45},t)$, $+(a_{45}'')^{(9,9,9)}(T_{45},t)$, $+(a_{46}'')^{(9,9,9)}(T_{45},t)$ are ninth augmentation coefficients for category 1, 2 and 3	
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[\begin{matrix} (b_{20}')^{(3)} - (b_{20}'')^{(3)}(G_{23},t) - (b_{16}'')^{(2,2,2)}(G_{19},t) - (b_{13}'')^{(1,1,1,)}(G,t) \\ -(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t) - (b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t) - (b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b_{36}'')^{(7,7,7,7)}(G_{39},t) - (b_{40}'')^{(8,8,8,8)}(G_{43},t) - (b_{44}'')^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{20}$	*70*
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[\begin{matrix} (b_{21}')^{(3)} - (b_{21}'')^{(3)}(G_{23},t) - (b_{17}'')^{(2,2,2)}(G_{19},t) - (b_{14}'')^{(1,1,1,)}(G,t) \\ -(b_{25}'')^{(4,4,4,4,4,4)}(G_{27},t) - (b_{29}'')^{(5,5,5,5,5,5)}(G_{31},t) - (b_{33}'')^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b_{37}'')^{(7,7,7,7)}(G_{39},t) - (b_{41}'')^{(8,8,8,8)}(G_{43},t) - (b_{45}'')^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{21}$	*71*
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[\begin{matrix} (b_{22}')^{(3)} - (b_{22}'')^{(3)}(G_{23},t) - (b_{18}'')^{(2,2,2)}(G_{19},t) - (b_{15}'')^{(1,1,1,)}(G,t) \\ -(b_{26}'')^{(4,4,4,4,4,4)}(G_{27},t) - (b_{30}'')^{(5,5,5,5,5,5)}(G_{31},t) - (b_{34}'')^{(6,6,6,6,6,6)}(G_{35},t) \\ -(b_{38}'')^{(7,7,7,7)}(G_{39},t) - (b_{42}'')^{(8,8,8,8)}(G_{43},t) - (b_{46}'')^{(9,9,9)}(G_{47},t) \end{matrix} \right] T_{22}$	*72*
$-(b_{20}'')^{(3)}(G_{23},t)$, $-(b_{21}'')^{(3)}(G_{23},t)$, $-(b_{22}'')^{(3)}(G_{23},t)$ *are first detrition coefficients for category 1, 2 and 3* $-(b_{16}'')^{(2,2,2)}(G_{19},t)$, $-(b_{17}'')^{(2,2,2)}(G_{19},t)$, $-(b_{18}'')^{(2,2,2)}(G_{19},t)$ *are second detrition coefficients for category 1, 2 and 3* $-(b_{13}'')^{(1,1,1,)}(G,t)$, $-(b_{14}'')^{(1,1,1,)}(G,t)$, $-(b_{15}'')^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3* $-(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b_{25}'')^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b_{26}'')^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detrition coefficients for category 1, 2 and 3* $-(b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b_{29}'')^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b_{30}'')^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detrition coefficients for category 1, 2 and 3* $-(b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b_{33}'')^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b_{34}'')^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detrition coefficients for category 1, 2 and 3* $-(b_{36}'')^{(7,7,7,7)}(G_{39},t)$, $-(b_{37}'')^{(7,7,7,7)}(G_{39},t)$ $-(b_{38}'')^{(7,7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1, 2 and 3 $-(b_{40}'')^{(8,8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8,8)}(G_{43},t)$, $-(b_{42}'')^{(8,8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1, 2 and 3	

$\boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a'_{24})^{(4)} \boxed{+(a''_{24})^{(4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a'_{25})^{(4)} \boxed{+(a''_{25})^{(4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a'_{26})^{(4)} \boxed{+(a''_{26})^{(4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a''_{24})^{(4)}(T_{25},t)}$, $\boxed{(a''_{25})^{(4)}(T_{25},t)}$, $\boxed{(a''_{26})^{(4)}(T_{25},t)}$ *are first augmentation coefficients category* 1, 2 3

$\boxed{+(a''_{28})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,)}(T_{29},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1)}(T_{14},t)}$ *are fourth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{16})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2)}(T_{17},t)}$ *are fifth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{20})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3)}(T_{21},t)}$ *are sixth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{36})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7)}(T_{37},t)}$ *are seventh augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$ *are eighth augmentation coefficients for category* 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \begin{bmatrix} (b'_{24})^{(4)} \boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \begin{bmatrix} (b'_{25})^{(4)} \boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \begin{bmatrix} (b_{26}^{'})^{(4)} \boxed{-(b_{26}^{''})^{(4)}(G_{27},t)} \boxed{-(b_{30}^{''})^{(5,5,)}(G_{31},t)} \boxed{-(b_{34}^{''})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1)}(G,t)} \boxed{-(b_{18}^{''})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b_{22}^{''})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b_{38}^{''})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b_{42}^{''})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b_{46}^{''})^{(9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{26}$$ 78

Where $\boxed{-(b_{24}^{''})^{(4)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{28}^{''})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{32}^{''})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{13}^{''})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1,1,1,1)}(G,t)}$ *are fourth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{16}^{''})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,2,2)}(G_{19},t)}$ *are fifth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{20}^{''})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,3,3)}(G_{23},t)}$ *are sixth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{36}^{''})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}^{''})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{38}^{''})^{(7,7,7,7,7)}(G_{39},t)}$ *are seventh detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{40}^{''})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}^{''})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}^{''})^{(8,8,8,8,8)}(G_{43},t)}$ *are eighth detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b_{46}^{''})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}^{''})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}^{''})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \begin{bmatrix} (a_{28}^{'})^{(5)} \boxed{+(a_{28}^{''})^{(5)}(T_{29},t)} \boxed{+(a_{24}^{''})^{(4,4,)}(T_{25},t)} \boxed{+(a_{32}^{''})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{28}$$ 79

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \begin{bmatrix} (a_{29}^{'})^{(5)} \boxed{+(a_{29}^{''})^{(5)}(T_{29},t)} \boxed{+(a_{25}^{''})^{(4,4,)}(T_{25},t)} \boxed{+(a_{33}^{''})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{14}^{''})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}^{''})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}^{''})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}^{''})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}^{''})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}^{''})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$$ 80

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \begin{bmatrix} (a_{30}^{'})^{(5)} \boxed{+(a_{30}^{''})^{(5)}(T_{29},t)} \boxed{+(a_{26}^{''})^{(4,4,)}(T_{25},t)} \boxed{+(a_{34}^{''})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}^{''})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}^{''})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}^{''})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}^{''})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}^{''})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$$ 81

Where $\boxed{+(a_{28}^{''})^{(5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a_{24}^{''})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a_{32}^{''})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}, \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}, \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3 $\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}, \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}, \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3	
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{matrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{28}$	82
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{matrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{29}$	83
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{matrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{30}$	84
$where \boxed{-(b''_{28})^{(5)}(G_{31},t)}, \boxed{-(b''_{29})^{(5)}(G_{31},t)}, \boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}, \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}, \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}, \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}, \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}, \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}, \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}, \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}, \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}, \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}, \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}, \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}, \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}, \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}, \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3	

$\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt}=(a_{32})^{(6)}G_{33}-\left[\begin{matrix}(a'_{32})^{(6)}\boxed{+(a''_{32})^{(6)}(T_{33},t)}\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{32}$	85
$\frac{dG_{33}}{dt}=(a_{33})^{(6)}G_{32}-\left[\begin{matrix}(a'_{33})^{(6)}\boxed{+(a''_{33})^{(6)}(T_{33},t)}\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{33}$	86
$\frac{dG_{34}}{dt}=(a_{34})^{(6)}G_{33}-\left[\begin{matrix}(a'_{34})^{(6)}\boxed{+(a''_{34})^{(6)}(T_{33},t)}\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}\\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}\end{matrix}\right]G_{34}$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt}=(b_{32})^{(6)}T_{33}-\left[\begin{matrix}(b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}\\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}\end{matrix}\right]T_{32}$	88

$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \begin{bmatrix} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{33}$	*89*
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \begin{bmatrix} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{34}$	*90*
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*91*
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	*92*

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15} \quad 93$$

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13} \quad 94$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{matrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{13}$	95
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[\begin{matrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[\begin{matrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second	

augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[\begin{matrix} (b'_{40})^{(8)}\boxed{-(b''_{40})^{(8)}(G_{43},t)} & \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{13}$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[\begin{matrix} (b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)} & \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{14}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[\begin{matrix} (b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[\begin{matrix} (a'_{44})^{(9)} \boxed{+(a''_{44})^{(9)}(T_{45},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{13} \quad 96$$

$$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[\begin{matrix} (a'_{45})^{(9)} \boxed{+(a''_{45})^{(9)}(T_{45},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[\begin{matrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{matrix}\right] G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)}\boxed{-(b''_{44})^{(9)}(G_{47},t)}\ \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \begin{bmatrix} (b'_{45})^{(9)}\boxed{-(b''_{45})^{(9)}(G_{47},t)}\ \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \begin{bmatrix} (b'_{46})^{(9)}\boxed{-(b''_{46})^{(9)}(G_{47},t)}\ \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\ \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\ \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{15}$$

Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3

$-(b_{37}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{36}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$, $-(b_{38}'')^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)$ are eighth detrition coefficients for category 1, 2 and 3 $-(b_{42}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{41}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$, $-(b_{40}'')^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a_i')^{(1)}, (a_i'')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (b_i'')^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a_i'')^{(1)}, (b_i'')^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a_i'')^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b_i'')^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b_i')^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2 \to \infty} (a_i'')^{(1)}(T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b_i'')^{(1)}(G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}$ are positive constants and $i = 13,14,15$	98
They satisfy Lipschitz condition: $\|(a_i'')^{(1)}(T_{14}',t) - (a_i'')^{(1)}(T_{14},t)\| \leq (\hat{k}_{13})^{(1)}\|T_{14} - T_{14}'\|e^{-(\hat{M}_{13})^{(1)}t}$ $\|(b_i'')^{(1)}(G',t) - (b_i'')^{(1)}(G,t)\| < (\hat{k}_{13})^{(1)}\|\|G - G'\|\|e^{-(\hat{M}_{13})^{(1)}t}$	99
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}} , \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$	100
Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}, i = 13,14,15,$	101

satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)}(\hat{k}_{13})^{(1)}] < 1$	
Where we suppose	
$(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$	
The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded.	
<u>Definition of</u> $(p_i)^{(2)}, (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t) \le (p_i)^{(2)} \le (\hat{A}_{16})^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t) \le (r_i)^{(2)} \le (b_i')^{(2)} \le (\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t) = (p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}((G_{19}),t) = (r_i)^{(2)}$	105
<u>Definition of</u> $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}}$ are positive constants and $\boxed{i = 16,17,18}$	106
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t)\rvert \le (\hat{k}_{16})^{(2)}\lvert T_{17} - T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert(b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert(G_{19}) - (G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and $(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}} , \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$	109
<u>Definition of</u> $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)}$ *and* $(\hat{B}_{16})^{(2)}$ and the constants	

$(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, \ (r_i)^{(2)}, i = 16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i')^{(2)} + (\hat{A}_{16})^{(2)} + (\hat{P}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1$	111
Where we suppose	
$(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$ The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)}, \ (\mathrm{r_i})^{(3)}$: $(a_i'')^{(3)}(T_{21}, t) \le (p_i)^{(3)} \le (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23}, t) \le \ (r_i)^{(3)} \le (b_i')^{(3)} \le (\hat{B}_{20})^{(3)}$	112
$lim_{T_2 \to \infty}(a_i'')^{(3)}(T_{21}, t) = (p_i)^{(3)}$ $\lim_{G \to \infty}(b_i'')^{(3)}(G_{23}, t) = \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, \ (r_i)^{(3)}$ are positive constants and $i = 20,21,22$	113
They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}', t) - (a_i'')^{(3)}(T_{21}, t)\| \le (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}', t) - (b_i'')^{(3)}(G_{23}, t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}', t)$ and$(a_i'')^{(3)}(T_{21}, t)$. (T_{21}', t) And (T_{21}, t) are points belonging to the interval $[(\hat{k}_{20})^{(3)}, (\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21}, t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and \, (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)}, (a_i^{'})^{(3)}, (b_i)^{(3)}, (b_i^{'})^{(3)}, (p_i)^{(3)}, \; (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i^{'})^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i^{'})^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)} (\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (a_i^{''})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (b_i^{''})^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i^{''})^{(4)}, (b_i^{''})^{(4)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(4)}, \; (r_i)^{(4)}$: $(a_i^{''})^{(4)}(T_{25}, t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i^{''})^{(4)}((G_{27}), t) \leq (r_i)^{(4)} \leq (b_i^{'})^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2 \to \infty} (a_i^{''})^{(4)} (T_{25}, t) = (p_i)^{(4)}$ $\lim_{G \to \infty} (b_i^{''})^{(4)} ((G_{27}), t) = (r_i)^{(4)}$ <u>**Definition of**</u> $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$: Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, \; (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$	118
They satisfy Lipschitz condition: $\lvert (a_i^{''})^{(4)}(T_{25}^{'}, t) - (a_i^{''})^{(4)}(T_{25}, t) \rvert \leq (\hat{k}_{24})^{(4)} \lvert T_{25} - T_{25}^{'} \rvert e^{-(\hat{M}_{24})^{(4)} t}$ $\lvert (b_i^{''})^{(4)}((G_{27})^{'}, t) - (b_i^{''})^{(4)}((G_{27}), t) \rvert < (\hat{k}_{24})^{(4)} \lvert\lvert (G_{27}) - (G_{27})^{'} \rvert\lvert e^{-(\hat{M}_{24})^{(4)} t}$	119
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'}, t)$ and$(a_i^{''})^{(4)}(T_{25}, t)$. $(T_{25}^{'}, t)$ and (T_{25}, t) are points belonging to the interval $\left[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)} \right]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 1$ then the function $(a_i^{''})^{(4)}(T_{25}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)},$ are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}} \;, \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$	120

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)}, (a_i')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26$, satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i')^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i')^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$	121
Where we suppose	
$(a_i)^{(5)}, (a_i')^{(5)}, (a_i'')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (b_i'')^{(5)} > 0, \quad i,j = 28,29,30$ The functions $(a_i'')^{(5)}, (b_i'')^{(5)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(5)}, (r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29}, t) \leq (p_i)^{(5)} \leq (\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}), t) \leq (r_i)^{(5)} \leq (b_i')^{(5)} \leq (\hat{B}_{28})^{(5)}$	122
$lim_{T_2 \to \infty}(a_i'')^{(5)}(T_{29}, t) = (p_i)^{(5)}$ $\lim_{G \to \infty}(b_i'')^{(5)}(G_{31}, t) = (r_i)^{(5)}$ **Definition of** $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28,29,30}$	123
They satisfy Lipschitz condition: $\lvert(a_i'')^{(5)}(T_{29}', t) - (a_i'')^{(5)}(T_{29}, t)\rvert \leq (\hat{k}_{28})^{(5)}\lvert T_{29} - T_{29}'\rvert e^{-(\hat{M}_{28})^{(5)}t}$ $\lvert(b_i'')^{(5)}((G_{31})', t) - (b_i'')^{(5)}((G_{31}), t)\rvert < (\hat{k}_{28})^{(5)}\lvert\lvert(G_{31}) - (G_{31})'\rvert\rvert e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}', t)$ and $(a_i'')^{(5)}(T_{29}, t)$. (T_{29}', t) and (T_{29}, t) are points belonging to the interval $[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}]$. It is to be noted that $(a_i'')^{(5)}(T_{29}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 1$ then the function $(a_i'')^{(5)}(T_{29}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants	125

$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}$, $\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$	
Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)}$ *and* $(\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)}, (a_i')^{(5)}, (b_i)^{(5)}, (b_i')^{(5)}, (p_i)^{(5)}, (r_i)^{(5)}, i = 28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[(a_i)^{(5)} + (a_i')^{(5)} + (\hat{A}_{28})^{(5)} + (\hat{P}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[(b_i)^{(5)} + (b_i')^{(5)} + (\hat{B}_{28})^{(5)} + (\hat{Q}_{28})^{(5)}(\hat{k}_{28})^{(5)}] < 1$	126
Where we suppose	
$(a_i)^{(6)}, (a_i')^{(6)}, (a_i'')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (b_i'')^{(6)} > 0, \quad i,j = 32,33,34$ The functions $(a_i'')^{(6)}, (b_i'')^{(6)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(6)}, (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33}, t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}), t) \leq (r_i)^{(6)} \leq (b_i')^{(6)} \leq (\hat{B}_{32})^{(6)}$	127
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With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}', t)$ and $(a_i'')^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33}, t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
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system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (MMMMMMMMM) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}$, $\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
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$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
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$(a_i)^{(9)}, (a_i')^{(9)}, (a_i^{''})^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i^{''})^{(9)} > 0, \quad i,j = 44,45,46$ The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(9)}, (r_i)^{(9)}$: $(a_i^{''})^{(9)}(T_{45},t) \le (p_i)^{(9)} \le (\hat{A}_{44})^{(9)}$ $(b_i^{''})^{(9)}(G_{47},t) \le (r_i)^{(9)} \le (b_i')^{(9)} \le (\hat{B}_{44})^{(9)}$	146 A
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They satisfy Lipschitz condition:	

$\lvert(a_i'')^{(9)}(T_{45}',t)-(a_i'')^{(9)}(T_{45},t)\rvert \leq (\hat{k}_{44})^{(9)}\lvert T_{45}-T_{45}'\rvert e^{-(\hat{M}_{44})^{(9)}t}$ $\lvert(b_i'')^{(9)}((G_{47})',t)-(b_i'')^{(9)}((G_{47}),t)\rvert < (\hat{k}_{44})^{(9)}\lvert\lvert(G_{47})-(G_{47})'\rvert\rvert e^{-(\hat{M}_{44})^{(9)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(9)}(T_{45}',t)$ and $(a_i'')^{(9)}(T_{45},t)$. (T_{45}',t) and (T_{45},t) are points belonging to the interval $[(\hat{k}_{44})^{(9)},(\hat{M}_{44})^{(9)}]$. It is to be noted that $(a_i'')^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)}=1$ then the function $(a_i'')^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$: $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)}$, are positive constants $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\ ,\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}<1$	
Definition of $(\hat{P}_{44})^{(9)},(\hat{Q}_{44})^{(9)}$: There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)},(\hat{k}_{44})^{(9)},(\hat{A}_{44})^{(9)} and\ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)},(a_i')^{(9)},(b_i)^{(9)},(b_i')^{(9)},(p_i)^{(9)},\ (r_i)^{(9)},i=44,45,46,$ satisfy the inequalities $\frac{1}{(\hat{M}_{44})^{(9)}}[(a_i)^{(9)}+(a_i')^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$ $\frac{1}{(\hat{M}_{44})^{(9)}}[(b_i)^{(9)}+(b_i')^{(9)}+(\hat{B}_{44})^{(9)}+(\hat{Q}_{44})^{(9)}(\hat{k}_{44})^{(9)}]<1$	
Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0),T_i(0)$: $G_i(t)\leq(\hat{P}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $G_i(0)=G_i^0>0$ $T_i(t)\leq(\hat{Q}_{13})^{(1)}e^{(\hat{M}_{13})^{(1)}t}$, $T_i(0)=T_i^0>0$	147
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$T_i(t) \leq \ (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t} \quad , \quad T_i(0) = T_i^0 > 0$	
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq \ (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq \ (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$	150
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$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)}t}$	157
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$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b'_{13})^{(1)} - (b''_{13})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b'_{14})^{(1)} - (b''_{14})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b'_{15})^{(1)} - (b''_{15})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$ Where $s_{(13)}$ is the integrand that is integrated over an interval $(0, t)$	
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)}t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a'_{16})^{(2)} + a''_{16})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)}$	

$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
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$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19}(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
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$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}^{'})^{(3)} + a_{20}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)}$	
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$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i, $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{24})^{(4)}$, $T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	

By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a'_{24})^{(4)} + a''_{24})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{24}(s_{(24)}) \right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a'_{25})^{(4)} + (a''_{25})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a'_{26})^{(4)} + (a''_{26})^{(4)} (T_{25}(s_{(24)}), s_{(24)}) \right) G_{26}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b'_{24})^{(4)} - (b''_{24})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{24}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b'_{25})^{(4)} - (b''_{25})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{25}(s_{(24)}) \right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b'_{26})^{(4)} - (b''_{26})^{(4)} (G_{27}(s_{(24)}), s_{(24)}) \right) T_{26}(s_{(24)}) \right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{28})^{(5)}$, $T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By $\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a'_{28})^{(5)} + a''_{28})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{28}(s_{(28)}) \right] ds_{(28)}$	163
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a'_{29})^{(5)} + (a''_{29})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a'_{30})^{(5)} + (a''_{30})^{(5)} (T_{29}(s_{(28)}), s_{(28)}) \right) G_{30}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b'_{28})^{(5)} - (b''_{28})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{28}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b'_{29})^{(5)} - (b''_{29})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{29}(s_{(28)}) \right] ds_{(28)}$	
$\bar{T}_{30}(t) = T_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b'_{30})^{(5)} - (b''_{30})^{(5)} (G_{31}(s_{(28)}), s_{(28)}) \right) T_{30}(s_{(28)}) \right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)}\ , T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{32}\ )^{(6)} e^{(\ \hat{M}_{32}\ )^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}^{'})^{(6)} + a_{32}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{32}(s_{(32)}) \right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)} (T_{33}(s_{(32)}), s_{(32)}) \right) G_{34}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{32}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{33}(s_{(32)}) \right] ds_{(32)}$	
$\bar{T}_{34}(t) = T_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)} (G_{35}(s_{(32)}), s_{(32)}) \right) T_{34}(s_{(32)}) \right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i\ ,\ T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\ ,\ T_i(0) = T_i^0\ ,\ G_i^0 \leq (\ \hat{P}_{36}\ )^{(7)}\ , T_i^0 \leq (\ \hat{Q}_{36}\ )^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\ \hat{P}_{36}\ )^{(7)} e^{(\ \hat{M}_{36}\ )^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\ \hat{Q}_{36}\ )^{(7)} e^{(\ \hat{M}_{36}\ )^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a_{36}^{'})^{(7)} + a_{36}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{36}(s_{(36)}) \right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)} (T_{37}(s_{(36)}), s_{(36)}) \right) G_{38}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{36}(s_{(36)}) \right] ds_{(36)}$	

$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{37}(s_{(36)}) \right] ds_{(36)}$	
$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)} (G_{39}(s_{(36)}), s_{(36)}) \right) T_{38}(s_{(36)}) \right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{40})^{(8)}, T_i^0 \leq (\hat{Q}_{40})^{(8)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a_{40}^{'})^{(8)} + a_{40}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{40}(s_{(40)}) \right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	

By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}(s_{(44)}), s_{(44)})\right) G_{46}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{44}(s_{(44)})\right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{45}(s_{(44)})\right] ds_{(44)}$	
$\bar{\mathrm{T}}_{46}(\mathrm{t}) = \mathrm{T}_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47}(s_{(44)}), s_{(44)})\right) T_{46}(s_{(44)})\right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}}\right)\right] ds_{(13)} =$ $(1 + (a_{13})^{(1)} t) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1\right)$	167
From which it follows that $(G_{13}(t) - G_{13}^0) e^{-(\hat{M}_{13})^{(1)} t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right) e^{\left(-\frac{(\hat{P}_{13})^{(1)} + G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	168
Analogous inequalities hold also for G_{14} , $G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} \left(G_{17}^0 + (\hat{P}_{16})^{(6)} e^{(\hat{M}_{16})^{(2)} s_{(16)}}\right)\right] ds_{(16)} =$ $(1 + (a_{16})^{(2)} t) G_{17}^0 + \frac{(a_{16})^{(2)} (\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left(e^{(\hat{M}_{16})^{(2)} t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0) e^{-(\hat{M}_{16})^{(2)} t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}} \left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right) e^{\left(-\frac{(\hat{P}_{16})^{(2)} + G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for G_{17} , $G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	171

$G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} \left(G_{21}^0 + (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} s_{(20)}} \right) \right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)} t\right) G_{21}^0 + \frac{(a_{20})^{(3)} (\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left(e^{(\hat{M}_{20})^{(3)} t} - 1 \right)$	
From which it follows that $(G_{20}(t) - G_{20}^0) e^{-(\hat{M}_{20})^{(3)} t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}} \left[\left((\hat{P}_{20})^{(3)} + G_{21}^0 \right) e^{\left(-\frac{(\hat{P}_{20})^{(3)} + G_{21}^0}{G_{21}^0} \right)} + (\hat{P}_{20})^{(3)} \right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} \left(G_{25}^0 + (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} s_{(24)}} \right) \right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)} t\right) G_{25}^0 + \frac{(a_{24})^{(4)} (\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left(e^{(\hat{M}_{24})^{(4)} t} - 1 \right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0) e^{-(\hat{M}_{24})^{(4)} t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}} \left[\left((\hat{P}_{24})^{(4)} + G_{25}^0 \right) e^{\left(-\frac{(\hat{P}_{24})^{(4)} + G_{25}^0}{G_{25}^0} \right)} + (\hat{P}_{24})^{(4)} \right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}} \right) \right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1 \right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0 \right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0} \right)} + (\hat{P}_{28})^{(5)} \right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}} \right) \right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1 \right)$	176

From which it follows that $(G_{32}(t) - G_{32}^0)e^{-(\hat{M}_{32})^{(6)}t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}}\left[\left((\hat{P}_{32})^{(6)} + G_{33}^0\right)e^{\left(-\frac{(\hat{P}_{32})^{(6)}+G_{33}^0}{G_{33}^0}\right)} + (\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for $G_{25}, G_{26}, T_{24}, T_{25}, T_{26}$	177
(kk) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)}\left(G_{37}^0 + (\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\right)\right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)}t\right)G_{37}^0 + \frac{(a_{36})^{(7)}(\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left(e^{(\hat{M}_{36})^{(7)}t} - 1\right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)}\left(G_{41}^0 + (\hat{P}_{40})^{(8)}e^{(\hat{M}_{40})^{(8)}s_{(40)}}\right)\right] ds_{(40)} =$ $\left(1 + (a_{40})^{(8)}t\right)G_{41}^0 + \frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t} - 1\right)$	180
From which it follows that $(G_{40}(t) - G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t} \leq \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)} + G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)} + (\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for $G_{41}, G_{42}, T_{40}, T_{41}, T_{42}$	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t) \leq G_{44}^0 + \int_0^t \left[(a_{44})^{(9)}\left(G_{45}^0 + (\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right] ds_{(44)} =$ $\left(1 + (a_{44})^{(9)}t\right)G_{45}^0 + \frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t} - 1\right)$	
From which it follows that $(G_{44}(t) - G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t} \leq \frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)} + G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)} + (\hat{P}_{44})^{(9)}\right]$	

(G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for $G_{45}, G_{46}, T_{44}, T_{45}, T_{46}$	
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$\frac{(a_i)^{(5)}}{(\mathcal{M}_{28})^{(5)}}\left[(\widehat{P}_{28})^{(5)}+((\widehat{P}_{28})^{(5)}+G_j^0)e^{-\left(\frac{(\widehat{P}_{28})^{(5)}+G_j^0}{G_j^0}\right)}\right]\leq(\widehat{P}_{28})^{(5)}$	234
$\frac{(b_i)^{(5)}}{(\mathcal{M}_{28})^{(5)}}\left[((\widehat{Q}_{28})^{(5)}+T_j^0)e^{-\left(\frac{(\widehat{Q}_{28})^{(5)}+T_j^0}{T_j^0}\right)}+(\widehat{Q}_{28})^{(5)}\right]\leq(\widehat{Q}_{28})^{(5)}$	235
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$(b_{29})^{(5)} - (b_i'')^{(5)}((G_{31})(t),t) < \varepsilon_5, T_{28}\ (t) > (m)^{(5)}$

Then $\frac{dT_{29}}{dt} \geq (a_{29})^{(5)}(m)^{(5)} - \varepsilon_5 T_{29}$ which leads to 243

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$T_{29}\ \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{2}\right), \quad t = log\frac{2}{\varepsilon_5}$ By taking now ε_5 sufficiently small one sees that T_{29} is unbounded. The same property holds for T_{30} if $\lim_{t\to\infty}(b_{30}'')^{(5)}\left((G_{31})(t),t\right) = (b_{30}')^{(5)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations

Analogous inequalities hold also for $G_{33}\ , G_{34}, T_{32}, T_{33}, T_{34}$

It is now sufficient to take $\frac{(a_i)^{(6)}}{(\hat{M}_{32}\ )^{(6)}}\ , \frac{(b_i)^{(6)}}{(\hat{M}_{32}\ )^{(6)}} < 1$ and to choose 244

$(\ \widehat{\mathrm{P}}_{32}\ )^{(6)}$ and $(\ \widehat{\mathrm{Q}}_{32}\ )^{(6)}$ large to have

$$\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[(\ \hat{P}_{32})^{(6)} + ((\ \hat{P}_{32}\ )^{(6)} + G_j^0)e^{-\left(\frac{(\ \hat{P}_{32}\ )^{(6)}+G_j^0}{G_j^0}\right)}\right] \leq (\ \hat{P}_{32}\ )^{(6)}$$ 245

$$\frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}}\left[((\ \hat{Q}_{32}\ )^{(6)} + T_j^0)e^{-\left(\frac{(\ \hat{Q}_{32}\ )^{(6)}+T_j^0}{T_j^0}\right)} + (\ \hat{Q}_{32}\ )^{(6)}\right] \leq (\ \hat{Q}_{32}\ )^{(6)}$$ 246

In order that the operator $\mathcal{A}^{(6)}$ transforms the space of sextuples of functions $G_i\ , T_i$ satisfying Equations into itself

The operator $\mathcal{A}^{(6)}$ is a contraction with respect to the metric 247

$$d\left(\left((G_{35})^{(1)}, (T_{35})^{(1)}\right), \left((G_{35})^{(2)}, (T_{35})^{(2)}\right)\right) =$$

$$\sup_i\{\max_{t\in\mathbb{R}_+} \left|G_i^{(1)}(t) - G_i^{(2)}(t)\right| e^{-(\hat{M}_{32})^{(6)}t}, \max_{t\in\mathbb{R}_+} \left|T_i^{(1)}(t) - T_i^{(2)}(t)\right| e^{-(\hat{M}_{32})^{(6)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{35})}, \widetilde{(T_{35})}$: $\left(\widetilde{(G_{35})}, \widetilde{(T_{35})}\right) = \mathcal{A}^{(6)}\left((G_{35}), (T_{35})\right)$

It results

$$\left|\tilde{G}_{32}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{32})^{(6)} \left|G_{33}^{(1)} - G_{33}^{(2)}\right| e^{-(\widehat{M}_{32})^{(6)} s_{(32)}} e^{(\widehat{M}_{32})^{(6)} s_{(32)}}\, ds_{(32)} +$$

$$\int_0^t \{(a_{32}')^{(6)}\left|G_{32}^{(1)} - G_{32}^{(2)}\right| e^{-(\widehat{M}_{32})^{(6)} s_{(32)}} e^{-(\widehat{M}_{32})^{(6)} s_{(32)}} +$$

$$(a_{32}'')^{(6)}\left(T_{33}^{(1)}, s_{(32)}\right)\left|G_{32}^{(1)} - G_{32}^{(2)}\right| e^{-(\widehat{M}_{32})^{(6)} s_{(32)}} e^{(\widehat{M}_{32})^{(6)} s_{(32)}} +$$

$G_{32}^{(2)}\|(a_{32}'')^{(6)}\big(T_{33}^{(1)}, s_{(32)}\big) - (a_{32}'')^{(6)}\big(T_{33}^{(2)}, s_{(32)}\big)\|\ e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$ Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	
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$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + ((\hat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)}$	267
$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[((\hat{Q}_{40})^{(8)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{40})^{(8)}\right] \leq (\hat{Q}_{40})^{(8)}$	268
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t) - G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t) - T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **Definition of** $\widetilde{(G_{43})}, \widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results	271

$\left\|\tilde{G}_{40}^{(1)}-\tilde{G}_{i}^{(2)}\right\| \leq \int_0^t (a_{40})^{(8)} \left\|G_{41}^{(1)}-G_{41}^{(2)}\right\| e^{-(\hat{M}_{40})^{(8)} s_{(40)}} e^{(\hat{M}_{40})^{(8)} s_{(40)}}\, ds_{(40)} +$ $\int_0^t \{(a_{40}')^{(8)} \left\|G_{40}^{(1)}-G_{40}^{(2)}\right\| e^{-(\hat{M}_{40})^{(8)} s_{(40)}} e^{-(\hat{M}_{40})^{(8)} s_{(40)}} +$ $(a_{40}'')^{(8)}(T_{41}^{(1)}, s_{(40)}) \left\|G_{40}^{(1)}-G_{40}^{(2)}\right\| e^{-(\hat{M}_{40})^{(8)} s_{(40)}} e^{(\hat{M}_{40})^{(8)} s_{(40)}} +$ $G_{40}^{(2)} \left\|(a_{40}'')^{(8)}(T_{41}^{(1)}, s_{(40)}) - (a_{40}'')^{(8)}(T_{41}^{(2)}, s_{(40)})\right\|\ e^{-(\hat{M}_{40})^{(8)} s_{(40)}} e^{(\hat{M}_{40})^{(8)} s_{(40)}}\} ds_{(40)}$	
Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,t]$ From the hypotheses it follows	272
$\left\|(G_{43})^{(1)}-(G_{43})^{(2)}\right\| e^{-(\hat{M}_{40})^{(8)} t} \leq$ $\frac{1}{(\hat{M}_{40})^{(8)}}\left((a_{40})^{(8)} + (a_{40}')^{(8)} + (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}(\hat{k}_{40})^{(8)}\right) d\left(\left((G_{43})^{(1)},(T_{43})^{(1)};\ (G_{43})^{(2)},(T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
<u>**Remark 36:**</u> The fact that we supposed $(a_{40}'')^{(8)}$ and $(b_{40}'')^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$ *and* $(\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(8)}$ and $(b_i'')^{(8)}, i = 40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
<u>**Remark 37**</u> There does not exist any t where $G_i\,(t)=0$ *and* $T_i\,(t)=0$ it results $G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)}-(a_i'')^{(8)}(T_{41}(s_{(40)}),s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i\,(t) \geq T_i^0 e^{(-(b_i')^{(8)} t)} > 0$ for $t > 0$	275
<u>**Definition of**</u> $\left((\hat{M}_{40})^{(8)}\right)_1, \left((\hat{M}_{40})^{(8)}\right)_2$ *and* $\left((\hat{M}_{40})^{(8)}\right)_3$: <u>**Remark 38:**</u> if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\hat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\hat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\hat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\hat{M}_{40})^{(8)}\right)_1/(a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\hat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\hat{M}_{40})^{(8)}\right)_2/(a_{42}')^{(8)}$	276

If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t),t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\big((G_{43})(t),t\big) < \varepsilon_8, T_{40}\ (t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\big((G_{43})(t),t(t),t\big) = (b_{42}')^{(8)}$	279
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}, \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$ and to choose $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ large to have	279 A
$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)} + ((\hat{P}_{44})^{(9)} + G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{44})^{(9)}$	
$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)} + T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{44})^{(9)}\right] \leq (\hat{Q}_{44})^{(9)}$	
In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i , T_i satisfying 39,35,36 into itself	
The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric $d\Big(\big((G_{47})^{(1)},(T_{47})^{(1)}\big),\big((G_{47})^{(2)},(T_{47})^{(2)}\big)\Big) =$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{44})^{(9)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{47})},\widetilde{(T_{47})} : \big(\widetilde{(G_{47})},\widetilde{(T_{47})}\big) = \mathcal{A}^{(9)}\big((G_{47}),(T_{47})\big)$ It results	

$$|\tilde{G}_{44}^{(1)} - \tilde{G}_i^{(2)}| \leq \int_0^t (a_{44})^{(9)} |G_{45}^{(1)} - G_{45}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \, ds_{(44)} +$$
$$\int_0^t \{(a_{44}')^{(9)} |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} +$$
$$(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) |G_{44}^{(1)} - G_{44}^{(2)}| e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} +$$
$$G_{44}^{(2)} |(a_{44}'')^{(9)} (T_{45}^{(1)}, s_{(44)}) - (a_{44}'')^{(9)} (T_{45}^{(2)}, s_{(44)})| \; e^{-(\widehat{M}_{44})^{(9)} s_{(44)}} e^{(\widehat{M}_{44})^{(9)} s_{(44)}} \} ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$|(G_{47})^{(1)} - G^{(2)}| e^{-(\widehat{M}_{44})^{(9)} t} \leq$$
$$\frac{1}{(\widehat{M}_{44})^{(9)}} \left((a_{44})^{(9)} + (a_{44}')^{(9)} + (\widehat{A}_{44})^{(9)} + (\widehat{P}_{44})^{(9)} (\widehat{k}_{44})^{(9)} \right) d \left(\left((G_{47})^{(1)}, (T_{47})^{(1)}; \; (G_{47})^{(2)}, (T_{47})^{(2)} \right) \right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a_{44}'')^{(9)}$ and $(b_{44}'')^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ *and* $(\widehat{Q}_{44})^{(9)} e^{(\widehat{M}_{44})^{(9)} t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(9)}$ and $(b_i'')^{(9)}, i = 44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t) = 0$ *and* $T_i(t) = 0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)} (T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)} \right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)} \right)_1, \left((\widehat{M}_{44})^{(9)} \right)_2$ *and* $\left((\widehat{M}_{44})^{(9)} \right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)} \right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$$G_{45} \leq \left((\widehat{M}_{44})^{(9)} \right)_2 = G_{45}^0 + 2(a_{45})^{(9)} \left((\widehat{M}_{44})^{(9)} \right)_1 / (a_{45}')^{(9)}$$

In the same way , one can obtain

$$G_{46} \leq \left((\widehat{M}_{44})^{(9)} \right)_3 = G_{46}^0 + 2(a_{46})^{(9)} \left((\widehat{M}_{44})^{(9)} \right)_2 / (a_{46}')^{(9)}$$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t),t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$. **Definition of** $(m)^{(9)}$ and ε_9 : Indeed let t_9 be so that for $t > t_9$ $(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t),t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$	
Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results $T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = log\frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded. The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t),t) = (b_{46}')^{(9)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92	
Behavior of the solutions of equation **Theorem** If we denote and define **Definition of** $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$: $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying $-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14},t) + (a_{14}'')^{(1)}(T_{14},t) \leq -(\sigma_1)^{(1)}$ $-(\tau_2)^{(1)} \leq -(b_{13}')^{(1)} + (b_{14}')^{(1)} - (b_{13}'')^{(1)}(G,t) - (b_{14}'')^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	280
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0, (\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0, (u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0, (\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0, (\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}(\nu^{(1)})^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}(u^{(1)})^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)},\ if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)}$, and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$	283

$(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)}, if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$(\frac{(a_{15})^{(1)} G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq$ $\frac{(a_{15})^{(1)} G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a'_{15})^{(1)})}[e^{(S_1)^{(1)}t} - e^{-(a'_{15})^{(1)}t}] + G_{15}^0 e^{-(a'_{15})^{(1)}t})$	286
$\boxed{T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)} + (r_{13})^{(1)})t}}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)} + (r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)} T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)} - (b'_{15})^{(1)})}\left[e^{(R_1)^{(1)}t} - e^{-(b'_{15})^{(1)}t}\right] + T_{15}^0 e^{-(b'_{15})^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)} T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)} + (r_{13})^{(1)} + (R_2)^{(1)})}\left[e^{((R_1)^{(1)} + (r_{13})^{(1)})t} - e^{-(R_2)^{(1)}t}\right] + T_{15}^0 e^{-(R_2)^{(1)}t}$	289
Definition of $(S_1)^{(1)}, (S_2)^{(1)}, (R_1)^{(1)}, (R_2)^{(1)}$:- Where $(S_1)^{(1)} = (a_{13})^{(1)}(m_2)^{(1)} - (a'_{13})^{(1)}$ $(S_2)^{(1)} = (a_{15})^{(1)} - (p_{15})^{(1)}$ $(R_1)^{(1)} = (b_{13})^{(1)}(\mu_2)^{(1)} - (b'_{13})^{(1)}$ $(R_2)^{(1)} = (b'_{15})^{(1)} - (r_{15})^{(1)}$	290
Behavior of the solutions of equation	291

Theorem 2: If we denote and define	
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a'_{16})^{(2)} + (a'_{17})^{(2)} - (a''_{16})^{(2)}(T_{17}, t) + (a''_{17})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b'_{16})^{(2)} + (b'_{17})^{(2)} - (b''_{16})^{(2)}((G_{19}), t) - (b''_{17})^{(2)}((G_{19}), t) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0$, $(\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0$, $(u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)}, , (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0$, $(\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0$, $(\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303
If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)},\ \boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)},\ \boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)},\ \boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)},\ \boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$, and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$	308
$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)},\ \boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$	309
Then the solution of global equations satisfies the inequalities	310

$G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$	
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t}$	311
$\left(\frac{(a_{18})^{(2)}G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})}\left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t}\right] + G_{18}^0 e^{-(S_2)^{(2)}t} \leq G_{18}(t) \leq\right.$ $\left.\frac{(a_{18})^{(2)}G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a'_{18})^{(2)})}\left[e^{(S_1)^{(2)}t} - e^{-(a'_{18})^{(2)}t}\right] + G_{18}^0 e^{-(a'_{18})^{(2)}t}\right)$	312
$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)}T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b'_{18})^{(2)})}\left[e^{(R_1)^{(2)}t} - e^{-(b'_{18})^{(2)}t}\right] + T_{18}^0 e^{-(b'_{18})^{(2)}t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)}T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})}\left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t}\right] + T_{18}^0 e^{-(R_2)^{(2)}t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a'_{16})^{(2)}$ $(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	317
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b'_{16})^{(2)}$ $(R_2)^{(2)} = (b'_{18})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a'_{20})^{(3)} + (a'_{21})^{(3)} - (a''_{20})^{(3)}(T_{21}, t) + (a''_{21})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b'_{20})^{(3)} + (b'_{21})^{(3)} - (b''_{20})^{(3)}(G_{23}, t) - (b''_{21})^{(3)}\big((G_{23}), t\big) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and	320

By $(\bar{\nu}_1)^{(3)} > 0$, $(\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0$, $(\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	
Definition of $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}$, $(m_2)^{(3)}$, $(\mu_1)^{(3)}$, $(\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}\ , \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)},$ and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}\ , \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)},$ and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)},\ \boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	322
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})} \left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t} \right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq \right.$ $\left. \frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a'_{22})^{(3)})} \left[e^{(S_1)^{(3)}t} - e^{-(a'_{22})^{(3)}t} \right] + G_{22}^0 e^{-(a'_{22})^{(3)}t} \right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)} - (b'_{22})^{(3)})} \left[e^{(R_1)^{(3)}t} - e^{-(b'_{22})^{(3)}t} \right] + T_{22}^0 e^{-(b'_{22})^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)})} \left[e^{((R_1)^{(3)} + (r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t} \right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327

Definition of $(S_1)^{(3)},(S_2)^{(3)},(R_1)^{(3)},(R_2)^{(3)}$:- Where $(S_1)^{(3)}=(a_{20})^{(3)}(m_2)^{(3)}-(a_{20}^{'})^{(3)}$ $(S_2)^{(3)}=(a_{22})^{(3)}-(p_{22})^{(3)}$ $(R_1)^{(3)}=(b_{20})^{(3)}(\mu_2)^{(3)}-(b_{20}^{'})^{(3)}$ $(R_2)^{(3)}=(b_{22}^{'})^{(3)}-(r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)},(\sigma_2)^{(4)},(\tau_1)^{(4)},(\tau_2)^{(4)}$: $(\sigma_1)^{(4)},(\sigma_2)^{(4)},(\tau_1)^{(4)},(\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)}\le-(a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}-(a_{24}^{''})^{(4)}(T_{25},t)+(a_{25}^{''})^{(4)}(T_{25},t)\le-(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)}\le-(b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(b_{24}^{''})^{(4)}\big((G_{27}),t\big)-(b_{25}^{''})^{(4)}\big((G_{27}),t\big)\le-(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)},(\nu_2)^{(4)},(u_1)^{(4)},(u_2)^{(4)},\nu^{(4)},u^{(4)}$: By $(\nu_1)^{(4)}>0,(\nu_2)^{(4)}<0$ and respectively $(u_1)^{(4)}>0,(u_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_1)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_1)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ and	329
Definition of $(\bar{\nu}_1)^{(4)},,(\bar{\nu}_2)^{(4)},(\bar{u}_1)^{(4)},(\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)}>0,(\bar{\nu}_2)^{(4)}<0$ and respectively $(\bar{u}_1)^{(4)}>0,(\bar{u}_2)^{(4)}<0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2+(\sigma_2)^{(4)}\nu^{(4)}-(a_{24})^{(4)}=0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2+(\tau_2)^{(4)}u^{(4)}-(b_{24})^{(4)}=0$ **Definition of** $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)},(\nu_0)^{(4)}$:- If we define $(m_1)^{(4)},(m_2)^{(4)},(\mu_1)^{(4)},(\mu_2)^{(4)}$ by $(m_2)^{(4)}=(\nu_0)^{(4)},(m_1)^{(4)}=(\nu_1)^{(4)},\ \boldsymbol{if}\ (\nu_0)^{(4)}<(\nu_1)^{(4)}$ $(m_2)^{(4)}=(\nu_1)^{(4)},(m_1)^{(4)}=(\bar{\nu}_1)^{(4)},\boldsymbol{if}\ (\nu_4)^{(4)}<(\nu_0)^{(4)}<(\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)}=\frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)}=(\nu_4)^{(4)},(m_1)^{(4)}=(\nu_0)^{(4)},\ \boldsymbol{if}\ (\bar{\nu}_4)^{(4)}<(\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)}=(u_0)^{(4)},(\mu_1)^{(4)}=(u_1)^{(4)},\ \boldsymbol{if}\ (u_0)^{(4)}<(u_1)^{(4)}$ $(\mu_2)^{(4)}=(u_1)^{(4)},(\mu_1)^{(4)}=(\bar{u}_1)^{(4)},\boldsymbol{if}\ (u_1)^{(4)}<(u_0)^{(4)}<(\bar{u}_1)^{(4)}$,	331

and $(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)}-(p_{24})^{(4)})t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)}-(p_{24})^{(4)}-(S_2)^{(4)})}\left[e^{((S_1)^{(4)}-(p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$ $\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$	336
<u>**Definition of**</u> $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$ $(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$ $(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$ $(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$	337
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$: $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)} \leq -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \leq -(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)} \leq -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}((G_{31}), t) - (b_{29}'')^{(5)}((G_{31}), t) \leq -(\tau_1)^{(5)}$	338
<u>**Definition of**</u> $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$:	339

By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ **Definition of** $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:- If we define $(m_1)^{(5)}$, $(m_2)^{(5)}$, $(\mu_1)^{(5)}, (\mu_2)^{(5)}$ by $(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)},$ ***if*** $(\nu_0)^{(5)} < (\nu_1)^{(5)}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, ***if*** $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)},$ ***if*** $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$	340
and analogously $(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},$ ***if*** $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, ***if*** $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)},$ ***if*** $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	341
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)}t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)}t}$	343
$\left(\frac{(a_{30})^{(5)}G_{28}^0}{(m_1)^{(5)}\left((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)}\right)}\left[e^{\left((S_1)^{(5)} - (p_{28})^{(5)}\right)t} - e^{-(S_2)^{(5)}t}\right] + G_{30}^0 e^{-(S_2)^{(5)}t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)}t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{\left((R_1)^{(5)} + (r_{28})^{(5)}\right)t}$	346

$\frac{(b_{30})^{(5)}T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)}-(b_{30}')^{(5)})}\left[e^{(R_1)^{(5)}t}-e^{-(b_{30}')^{(5)}t}\right]+T_{30}^0 e^{-(b_{30}')^{(5)}t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)}T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)}+(r_{28})^{(5)}+(R_2)^{(5)})}\left[e^{((R_1)^{(5)}+(r_{28})^{(5)})t}-e^{-(R_2)^{(5)}t}\right]+T_{30}^0 e^{-(R_2)^{(5)}t}$	347
Definition of $(S_1)^{(5)},(S_2)^{(5)},(R_1)^{(5)},(R_2)^{(5)}$:- Where $(S_1)^{(5)}=(a_{28})^{(5)}(m_2)^{(5)}-(a_{28}')^{(5)}$ $(S_2)^{(5)}=(a_{30})^{(5)}-(p_{30})^{(5)}$ $(R_1)^{(5)}=(b_{28})^{(5)}(\mu_2)^{(5)}-(b_{28}')^{(5)}$ $(R_2)^{(5)}=(b_{30}')^{(5)}-(r_{30})^{(5)}$	348
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$: $(\sigma_1)^{(6)},(\sigma_2)^{(6)},(\tau_1)^{(6)},(\tau_2)^{(6)}$ four constants satisfying $-(\sigma_2)^{(6)} \leq -(a_{32}')^{(6)}+(a_{33}')^{(6)}-(a_{32}'')^{(6)}(T_{33},t)+(a_{33}'')^{(6)}(T_{33},t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b_{32}')^{(6)}+(b_{33}')^{(6)}-(b_{32}'')^{(6)}((G_{35}),t)-(b_{33}'')^{(6)}((G_{35}),t) \leq -(\tau_1)^{(6)}$	349
Definition of $(\nu_1)^{(6)},(\nu_2)^{(6)},(u_1)^{(6)},(u_2)^{(6)},\nu^{(6)},u^{(6)}$: By $(\nu_1)^{(6)}>0,(\nu_2)^{(6)}<0$ and respectively $(u_1)^{(6)}>0,(u_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2+(\sigma_1)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}(u^{(6)})^2+(\tau_1)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},,(\bar{\nu}_2)^{(6)},(\bar{u}_1)^{(6)},(\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)}>0,(\bar{\nu}_2)^{(6)}<0$ and respectively $(\bar{u}_1)^{(6)}>0,(\bar{u}_2)^{(6)}<0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2+(\sigma_2)^{(6)}\nu^{(6)}-(a_{32})^{(6)}=0$ and $(b_{33})^{(6)}(u^{(6)})^2+(\tau_2)^{(6)}u^{(6)}-(b_{32})^{(6)}=0$ **Definition of** $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)},(\nu_0)^{(6)}$:- If we define $(m_1)^{(6)},(m_2)^{(6)},(\mu_1)^{(6)},(\mu_2)^{(6)}$ by $(m_2)^{(6)}=(\nu_0)^{(6)},(m_1)^{(6)}=(\nu_1)^{(6)},$ ***if*** $(\nu_0)^{(6)}<(\nu_1)^{(6)}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\bar{\nu}_6)^{(6)},$ ***if*** $(\nu_1)^{(6)}<(\nu_0)^{(6)}<(\bar{\nu}_1)^{(6)},$ and $\boxed{(\nu_0)^{(6)}=\frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)}=(\nu_1)^{(6)},(m_1)^{(6)}=(\nu_0)^{(6)},$ ***if*** $(\bar{\nu}_1)^{(6)}<(\nu_0)^{(6)}$	351

and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},\ \boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}\ , \boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)},$ and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355
$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
<u>**Definition of**</u> $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:	

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \leq -(\tau_1)^{(7)}$	
Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and	361
Definition of $(\bar{\nu}_1)^{(7)},, (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: By $(\bar{\nu}_1)^{(7)} > 0, (\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0, (\bar{u}_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ **Definition of** $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:- If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by $(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$, and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	362
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$, and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
Then the solution of global equations satisfies the inequalities $G_{36}^0 e^{\left((S_1)^{(7)} - (p_{36})^{(7)}\right)t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$	364

where $(p_i)^{(7)}$ is defined by equation	
$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \le G_{37}(t) \le \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$	365
$(\frac{(a_{38})^{(7)}G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \le G_{38}(t) \le$ $\frac{(a_{38})^{(7)}G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a'_{38})^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a'_{38})^{(7)}t}] + G_{38}^0 e^{-(a'_{38})^{(7)}t})$	366
$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \le T_{36}(t) \le T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \le T_{36}(t) \le \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)}T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b'_{38})^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b'_{38})^{(7)}t}\right] + T_{38}^0 e^{-(b'_{38})^{(7)}t} \le T_{38}(t) \le$ $\frac{(a_{38})^{(7)}T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$	369
<u>**Definition of**</u> $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a'_{36})^{(7)}$ $(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$ $(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$	370
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \le -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \le -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \le -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \le -(\tau_1)^{(8)}$	371
<u>**Definition of**</u> $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$	372

and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(8)},, (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\left(u^{(8)}\right)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ **Definition of** $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:- If we define $(m_1)^{(8)}$, $(m_2)^{(8)}$, $(\mu_1)^{(8)}, (\mu_2)^{(8)}$ by $(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_0)^{(8)} < (\nu_1)^{(8)}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}$, $\boldsymbol{if}$ $(\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)}$, and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$ $(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$	
and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}$, $\boldsymbol{if}$ $(u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}$, $\boldsymbol{if}$ $(u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)}$, and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
Then the solution of global equations satisfies the inequalities $G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{40}(t) \leq G_{40}^0 e^{(S_1)^{(8)}t}$ where $(p_i)^{(8)}$ is defined by equation	375
$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)}t}$	376
$\left(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)})}\left[e^{((S_1)^{(8)} - (p_{40})^{(8)})t} - e^{-(S_2)^{(8)}t}\right] + G_{42}^0 e^{-(S_2)^{(8)}t} \leq G_{42}(t) \leq\right.$ $\left.\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)} - (a_{42}')^{(8)})}\left[e^{(S_1)^{(8)}t} - e^{-(a_{42}')^{(8)}t}\right] + G_{42}^0 e^{-(a_{42}')^{(8)}t}\right)$	377

$T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)}t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)}+(r_{40})^{(8)})t}$	379
$\frac{(b_{42})^{(8)} T_{40}^0}{(\mu_1)^{(8)}((R_1)^{(8)}-(b'_{42})^{(8)})}\left[e^{(R_1)^{(8)}t} - e^{-(b'_{42})^{(8)}t}\right] + T_{42}^0 e^{-(b'_{42})^{(8)}t} \leq T_{42}(t) \leq$ $\frac{(a_{42})^{(8)} T_{40}^0}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t} - e^{-(R_2)^{(8)}t}\right] + T_{42}^0 e^{-(R_2)^{(8)}t}$	380
Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a'_{40})^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b'_{40})^{(8)}$ $(R_2)^{(8)} = (b'_{42})^{(8)} - (r_{42})^{(8)}$	381
Behavior of the solutions of equation 37 to 92 **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$: $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying $-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$ $-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}((G_{47}), t) - (b''_{45})^{(9)}((G_{47}), t) \leq -(\tau_1)^{(9)}$	382
Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$: By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$: By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}(\nu^{(9)})^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$ and $(b_{45})^{(9)}(u^{(9)})^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ **Definition of** $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:- If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by $(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \; \boldsymbol{if} \; (\nu_0)^{(9)} < (\nu_1)^{(9)}$	

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}$, **if** $(\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)}$,
and $(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}$

$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}$, **if** $(\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$

and analogously

$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}$, **if** $(u_0)^{(9)} < (u_1)^{(9)}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}$, **if** $(u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)}$,
and $(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}$, **if** $(\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)} t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{((S_1)^{(9)} - (p_{44})^{(9)})t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)} t}$$

$$\Big(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)} - (p_{44})^{(9)} - (S_2)^{(9)})} \left[e^{((S_1)^{(9)} - (p_{44})^{(9)})t} - e^{-(S_2)^{(9)} t} \right] + G_{46}^0 e^{-(S_2)^{(9)} t} \leq G_{46}(t) \leq$$
$$\frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)} - (a_{46}')^{(9)})} [e^{(S_1)^{(9)} t} - e^{-(a_{46}')^{(9)} t}] + G_{46}^0 e^{-(a_{46}')^{(9)} t} \Big)$$

$$T_{44}^0 e^{(R_1)^{(9)} t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)} + (r_{44})^{(9)})t}$$

$$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)} t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)} + (r_{44})^{(9)})t}$$

$$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)} - (b_{46}')^{(9)})} \left[e^{(R_1)^{(9)} t} - e^{-(b_{46}')^{(9)} t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)} t} \leq T_{46}(t) \leq$$

$$\frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)} + (r_{44})^{(9)} + (R_2)^{(9)})} \left[e^{((R_1)^{(9)} + (r_{44})^{(9)})t} - e^{-(R_2)^{(9)} t} \right] + T_{46}^0 e^{-(R_2)^{(9)} t}$$

Definition of $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:-

Where $(S_1)^{(9)} = (a_{44})^{(9)} (m_2)^{(9)} - (a_{44}')^{(9)}$

$(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$

$(R_1)^{(9)} = (b_{44})^{(9)} (\mu_2)^{(9)} - (b_{44}')^{(9)}$

$$(R_2)^{(9)} = (b_{46}^{'})^{(9)} - (r_{46})^{(9)}$$

Proof : From global equations we obtain 383

$$\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}^{'})^{(1)} - (a_{14}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14},t)\right) - (a_{14}^{''})^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$$

Definition of $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$

It follows

$$-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \le \frac{d\nu^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:-

For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$

$$\nu^{(1)}(t) \ge \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}} \quad , \quad \boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$$

it follows $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\nu_1)^{(1)}$

In the same manner , we get 384

$$\nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$$

From which we deduce $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\bar{\nu}_1)^{(1)}$

If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, 385

$$(\nu_1)^{(1)} \le \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \le \nu^{(1)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\bar{\nu}_1)^{(1)}$$

If $0 < (\nu_1)^{(1)} \le (\bar{\nu}_1)^{(1)} \le \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain 386

$$(\nu_1)^{(1)} \le \nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\nu_0)^{(1)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(1)}(t)$:-

$$(m_2)^{(1)} \leq \nu^{(1)}(t) \leq (m_1)^{(1)}, \quad \boxed{\nu^{(1)}(t) = \frac{G_{13}(t)}{G_{14}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(1)}(t)$:-

$$(\mu_2)^{(1)} \leq u^{(1)}(t) \leq (\mu_1)^{(1)}, \quad \boxed{u^{(1)}(t) = \frac{T_{13}(t)}{T_{14}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{13})^{(1)} = (a''_{14})^{(1)}, then\ (\sigma_1)^{(1)} = (\sigma_2)^{(1)}$ and in this case $(\nu_1)^{(1)} = (\bar{\nu}_1)^{(1)}$ if in addition $(\nu_0)^{(1)} = (\nu_1)^{(1)}$ then $\nu^{(1)}(t) = (\nu_0)^{(1)}$ and as a consequence $G_{13}(t) = (\nu_0)^{(1)} G_{14}(t)$ this also defines $(\nu_0)^{(1)}$ for the special case

Analogously if $(b''_{13})^{(1)} = (b''_{14})^{(1)}, then\ (\tau_1)^{(1)} = (\tau_2)^{(1)}$ and then

$(u_1)^{(1)} = (\bar{u}_1)^{(1)}$if in addition $(u_0)^{(1)} = (u_1)^{(1)}$ then $T_{13}(t) = (u_0)^{(1)} T_{14}(t)$ This is an important consequence of the relation between $(\nu_1)^{(1)}$ and $(\bar{\nu}_1)^{(1)}$, and definition of $(u_0)^{(1)}$.

Proof : From global equations we obtain 387

$$\frac{d\nu^{(2)}}{dt} = (a_{16})^{(2)} - \left((a'_{16})^{(2)} - (a'_{17})^{(2)} + (a''_{16})^{(2)}(T_{17}, t)\right) - (a''_{17})^{(2)}(T_{17}, t)\nu^{(2)} - (a_{17})^{(2)}\nu^{(2)}$$

Definition of $\nu^{(2)}$:- $\boxed{\nu^{(2)} = \frac{G_{16}}{G_{17}}}$ 388

It follows 389

$$-\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right) \leq \frac{d\nu^{(2)}}{dt} \leq -\left((a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)}\right)$$

From which one obtains 390

Definition of $(\bar{\nu}_1)^{(2)}, (\nu_0)^{(2)}$:-

For $0 < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\nu_1)^{(2)} < (\bar{\nu}_1)^{(2)}$

$$\nu^{(2)}(t) \geq \frac{(\nu_1)^{(2)} + (C)^{(2)}(\nu_2)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}}{1 + (C)^{(2)} e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)} - (\nu_0)^{(2)}\right)t\right]}} \quad , \quad \boxed{(C)^{(2)} = \frac{(\nu_1)^{(2)} - (\nu_0)^{(2)}}{(\nu_0)^{(2)} - (\nu_2)^{(2)}}}$$

it follows $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\nu_1)^{(2)}$

In the same manner , we get $\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	391
From which we deduce $(\nu_0)^{(2)} \leq \nu^{(2)}(t) \leq (\bar{\nu}_1)^{(2)}$	392
If $0 < (\nu_1)^{(2)} < (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0} < (\bar{\nu}_1)^{(2)}$ we find like in the previous case, $(\nu_1)^{(2)} \leq \frac{(\nu_1)^{(2)}+(C)^{(2)}(\nu_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}}{1+(C)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\nu_1)^{(2)}-(\nu_2)^{(2)}\right)t\right]}} \leq \nu^{(2)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\bar{\nu}_1)^{(2)}$	393
If $0 < (\nu_1)^{(2)} \leq (\bar{\nu}_1)^{(2)} \leq (\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$, we obtain $(\nu_1)^{(2)} \leq \nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}} \leq (\nu_0)^{(2)}$ And so with the notation of the first part of condition (c) , we have	394
Definition of $\nu^{(2)}(t)$:- $(m_2)^{(2)} \leq \nu^{(2)}(t) \leq (m_1)^{(2)}$, $\boxed{\nu^{(2)}(t) = \frac{G_{16}(t)}{G_{17}(t)}}$	395
In a completely analogous way, we obtain **Definition of** $u^{(2)}(t)$:- $(\mu_2)^{(2)} \leq u^{(2)}(t) \leq (\mu_1)^{(2)}$, $\boxed{u^{(2)}(t) = \frac{T_{16}(t)}{T_{17}(t)}}$	396
Now, using this result and replacing it in global equations we get easily the result stated in the theorem.	
Particular case : If $(a_{16}'')^{(2)} = (a_{17}'')^{(2)}, then\ (\sigma_1)^{(2)} = (\sigma_2)^{(2)}$ and in this case $(\nu_1)^{(2)} = (\bar{\nu}_1)^{(2)}$ if in addition $(\nu_0)^{(2)} = (\nu_1)^{(2)}$ then $\nu^{(2)}(t) = (\nu_0)^{(2)}$ and as a consequence $G_{16}(t) = (\nu_0)^{(2)}G_{17}(t)$ Analogously if $(b_{16}'')^{(2)} = (b_{17}'')^{(2)}, then\ (\tau_1)^{(2)} = (\tau_2)^{(2)}$ and then $(u_1)^{(2)} = (\bar{u}_1)^{(2)}$if in addition $(u_0)^{(2)} = (u_1)^{(2)}$ then $T_{16}(t) = (u_0)^{(2)}T_{17}(t)$ This is an important consequence of the relation between $(\nu_1)^{(2)}$ and $(\bar{\nu}_1)^{(2)}$	397

Proof : From global equations we obtain $\frac{d\nu^{(3)}}{dt} = (a_{20})^{(3)} - \left((a'_{20})^{(3)} - (a'_{21})^{(3)} + (a''_{20})^{(3)}(T_{21},t)\right) - (a''_{21})^{(3)}(T_{21},t)\nu^{(3)} - (a_{21})^{(3)}\nu^{(3)}$	398
Definition of $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
From which one obtains For $0 < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\nu_1)^{(3)} < (\bar{\nu}_1)^{(3)}$ $\nu^{(3)}(t) \geq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_0)^{(3)}\right)t\right]}}$, $\boxed{(C)^{(3)} = \frac{(\nu_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\nu_2)^{(3)}}}$ it follows $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\nu_1)^{(3)}$	400
In the same manner , we get $\nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}$, $\boxed{(\bar{C})^{(3)} = \frac{(\bar{\nu}_1)^{(3)} - (\nu_0)^{(3)}}{(\nu_0)^{(3)} - (\bar{\nu}_2)^{(3)}}}$ **Definition of** $(\bar{\nu}_1)^{(3)}$:- From which we deduce $(\nu_0)^{(3)} \leq \nu^{(3)}(t) \leq (\bar{\nu}_1)^{(3)}$	401
If $0 < (\nu_1)^{(3)} < (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0} < (\bar{\nu}_1)^{(3)}$ we find like in the previous case, $(\nu_1)^{(3)} \leq \frac{(\nu_1)^{(3)} + (C)^{(3)}(\nu_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}}{1 + (C)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\nu_1)^{(3)} - (\nu_2)^{(3)}\right)t\right]}} \leq \nu^{(3)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\bar{\nu}_1)^{(3)}$	402
If $0 < (\nu_1)^{(3)} \leq (\bar{\nu}_1)^{(3)} \leq (\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}$, we obtain $(\nu_1)^{(3)} \leq \nu^{(3)}(t) \leq \frac{(\bar{\nu}_1)^{(3)} + (\bar{C})^{(3)}(\bar{\nu}_2)^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}}{1 + (\bar{C})^{(3)}e^{\left[-(a_{21})^{(3)}\left((\bar{\nu}_1)^{(3)} - (\bar{\nu}_2)^{(3)}\right)t\right]}} \leq (\nu_0)^{(3)}$ And so with the notation of the first part of condition (c) , we have	403

Definition of $\nu^{(3)}(t)$:-

$$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}, \quad \boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}, \quad \boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25},t)\right) - (a''_{25})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$	
If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, $(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$	406
If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain $(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(4)}(t)$:- $(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$ In a completely analogous way, we obtain **Definition of** $u^{(4)}(t)$:- $(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case .** Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$ if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.	407
Proof : From global equations we obtain $\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$ **Definition of** $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$ It follows	408

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)\leq\frac{d\nu^{(5)}}{dt}\leq-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)},(\nu_0)^{(5)}$:-

For $0<\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}<(\nu_1)^{(5)}<(\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t)\geq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}{5+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_0)^{(5)}\right)t\right]}}\quad,\quad\boxed{(C)^{(5)}=\frac{(\nu_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{5+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(5)}=\frac{(\bar{\nu}_1)^{(5)}-(\nu_0)^{(5)}}{(\nu_0)^{(5)}-(\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)}\leq\nu^{(5)}(t)\leq(\bar{\nu}_5)^{(5)}$

If $0<(\nu_1)^{(5)}<(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}<(\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)}\leq\frac{(\nu_1)^{(5)}+(C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}{1+(C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)}-(\nu_2)^{(5)}\right)t\right]}}\leq\nu^{(5)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\bar{\nu}_1)^{(5)}$$

If $0<(\nu_1)^{(5)}\leq(\bar{\nu}_1)^{(5)}\leq\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)}\leq\nu^{(5)}(t)\leq\frac{(\bar{\nu}_1)^{(5)}+(\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}{1+(\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)}-(\bar{\nu}_2)^{(5)}\right)t\right]}}\leq(\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)}\leq\nu^{(5)}(t)\leq(m_1)^{(5)}$, $\boxed{\nu^{(5)}(t)=\frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)}\leq u^{(5)}(t)\leq(\mu_1)^{(5)}$, $\boxed{u^{(5)}(t)=\frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a_{28}'')^{(5)} = (a_{29}'')^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .**

Analogously if $(b_{28}'')^{(5)} = (b_{29}'')^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

Proof : From global equations we obtain 412

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a_{32}')^{(6)} - (a_{33}')^{(6)} + (a_{32}'')^{(6)}(T_{33}, t)\right) - (a_{33}'')^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \le \frac{d\nu^{(6)}}{dt} \le -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \ge \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\nu_1)^{(6)}$

In the same manner , we get 413

$$\nu^{(6)}(t) \le \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$$

From which we deduce $(\nu_0)^{(6)} \le \nu^{(6)}(t) \le (\bar{\nu}_1)^{(6)}$

If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 414

$$(\nu_1)^{(6)} \le \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \le \nu^{(6)}(t) \le$$

$$\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \le (\bar{\nu}_1)^{(6)}$$

If $0 < (\nu_1)^{(6)} \le (\bar{\nu}_1)^{(6)} \le \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 415

$$(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)}+(\bar{C})^{(6)}(\bar{\nu}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)}-(\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get $\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	417
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}$ In a completely analogous way, we obtain	419
Definition of $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **Particular case :** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)} e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have	424

<u>**Definition of**</u> $\nu^{(8)}(t)$:-

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

<u>**Definition of**</u> $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

<u>**Particular case :**</u>

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

<u>**Proof**</u> : From 99,20,44,22,23,44 we obtain 424 A

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45}, t)\right) - (a''_{45})^{(9)}(T_{45}, t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

<u>**Definition of**</u> $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

<u>**Definition of**</u> $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G^0_{44}}{G^0_{45}}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)}=\frac{(\bar{\nu}_1)^{(9)}-(\nu_0)^{(9)}}{(\nu_0)^{(9)}-(\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0<(\nu_1)^{(9)}<(\nu_0)^{(9)}=\frac{G_{44}^0}{G_{45}^0}<(\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0<(\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)}=\frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)}e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t)=\frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t)=\frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a_{44}'')^{(9)}=(a_{45}'')^{(9)}, then\ (\sigma_1)^{(9)}=(\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)}=(\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)}=(\nu_1)^{(9)}$ then $\nu^{(9)}(t)=(\nu_0)^{(9)}$ and as a consequence $G_{44}(t)=(\nu_0)^{(9)}G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b_{44}'')^{(9)}=(b_{45}'')^{(9)}, then\ (\tau_1)^{(9)}=(\tau_2)^{(9)}$ and then $(u_1)^{(9)}=(\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)}=(u_1)^{(9)}$ then $T_{44}(t)=(u_0)^{(9)}T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a_i'')^{(1)} and\ (b_i'')^{(1)}$ are independent on t , and the conditions with the notations

$$(a_{13}')^{(1)}(a_{14}')^{(1)}-(a_{13})^{(1)}(a_{14})^{(1)}<0$$

$$(a_{13}')^{(1)}(a_{14}')^{(1)}-(a_{13})^{(1)}(a_{14})^{(1)}+(a_{13})^{(1)}(p_{13})^{(1)}+(a_{14}')^{(1)}(p_{14})^{(1)}+(p_{13})^{(1)}(p_{14})^{(1)}>0$$

$(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0$, $(b_{13}')^{(1)}(b_{14}')^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b_{13}')^{(1)}(r_{14})^{(1)} - (b_{14}')^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$ $with\ (p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i'')^{(2)} and\ (b_i'')^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}')^{(2)}(a_{17}')^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}')^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}')^{(2)}(b_{17}')^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}')^{(2)}(r_{17})^{(2)} - (b_{17}')^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ $with\ (p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i'')^{(3)} and\ (b_i'')^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}')^{(3)}(a_{21}')^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}')^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}')^{(3)}(r_{21})^{(3)} - (b_{21}')^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ $with\ (p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i'')^{(4)} and\ (b_i'')^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}')^{(4)}(a_{25}')^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}')^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}')^{(4)}(r_{25})^{(4)} - (b_{25}')^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ $with\ (p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i'')^{(5)} and\ (b_i'')^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}')^{(5)}(a_{29}')^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}')^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$,	433

$(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ $with$ $(p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	
Theorem If $(a_i^{''})^{(6)} and\ (b_i^{''})^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}^{'})^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}^{'})^{(6)}(b_{33}^{'})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}^{'})^{(6)}(r_{33})^{(6)} - (b_{33}^{'})^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with$ $(p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i^{''})^{(7)} and\ (b_i^{''})^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}^{'})^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}^{'})^{(7)}(r_{37})^{(7)} - (b_{37}^{'})^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with$ $(p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}^{'})^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}^{'})^{(8)}(r_{41})^{(8)} - (b_{41}^{'})^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with$ $(p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i^{''})^{(9)} and\ (b_i^{''})^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}^{'})^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$	436 A

$(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b'_{44})^{(9)}(r_{45})^{(9)} - (b'_{45})^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$ $with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - \left[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14})\right]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - \left[(a'_{14})^{(1)} + (a''_{14})^{(1)}(T_{14})\right]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - \left[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14})\right]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b'_{13})^{(1)} - (b''_{13})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b'_{14})^{(1)} - (b''_{14})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b'_{15})^{(1)} - (b''_{15})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - \left[(a'_{16})^{(2)} + (a''_{16})^{(2)}(T_{17})\right]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - \left[(a'_{17})^{(2)} + (a''_{17})^{(2)}(T_{17})\right]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - \left[(a'_{18})^{(2)} + (a''_{18})^{(2)}(T_{17})\right]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - \left[(a'_{20})^{(3)} + (a''_{20})^{(3)}(T_{21})\right]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - \left[(a'_{21})^{(3)} + (a''_{21})^{(3)}(T_{21})\right]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - \left[(a'_{22})^{(3)} + (a''_{22})^{(3)}(T_{21})\right]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b'_{20})^{(3)} - (b''_{20})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b'_{21})^{(3)} - (b''_{21})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b'_{22})^{(3)} - (b''_{22})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0$	455

$(a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})\right]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})\right]G_{26} = 0$	457
$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27})\right)]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27})\right)]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27})\right)]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\right]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\right]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\right]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\right]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\right]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\right]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0$	473

$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0$	474
$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a_{13}^{'})^{(1)}(a_{14}^{'})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13}^{'})^{(1)}(a_{14}^{''})^{(1)}(T_{14}) + (a_{14}^{'})^{(1)}(a_{13}^{''})^{(1)}(T_{14}) + (a_{13}^{''})^{(1)}(T_{14})(a_{14}^{''})^{(1)}(T_{14}) = 0$	485
Proof: (kk) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if	486

$F(T_{19}) = (a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16}^{'})^{(2)}(a_{17}^{''})^{(2)}(T_{17}) + (a_{17}^{'})^{(2)}(a_{16}^{''})^{(2)}(T_{17}) + (a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) +$	492 A

$(a_{44}'')^{(9)}(T_{45})(a_{45}'')^{(9)}(T_{45}) = 0$	
Definition and uniqueness of T_{14}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^* for which $f(T_{14}^*) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^*)]}$	493
Definition and uniqueness of T_{17}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^* for which $f(T_{17}^*) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^*)]}$	495
Definition and uniqueness of T_{21}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^* for which $f(T_{21}^*) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^*)]}$	496
Definition and uniqueness of T_{25}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^* for which $f(T_{25}^*) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^*)]}$	497
Definition and uniqueness of T_{29}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^* for which $f(T_{29}^*) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^*)]}$	498
Definition and uniqueness of T_{33}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^* for which $f(T_{33}^*) = 0$. With this value , we obtain from the three first	499

equations $G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$	
Definition and uniqueness of T_{37}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$	500
Definition and uniqueness of T_{41}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^{*})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^{*})]}$	501
Definition and uniqueness of T_{45}^{*} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T_{45}^{*} for which $f(T_{45}^{*}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^{*})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^{*})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right] + (b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b_{16}^{'})^{(2)}(b_{17}^{''})^{(2)}(G_{19}) + (b_{17}^{'})^{(2)}(b_{16}^{''})^{(2)}(G_{19})\right] + (b_{16}^{''})^{(2)}(G_{19})(b_{17}^{''})^{(2)}(G_{19}) = 0$	503

Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^* such that $\varphi((G_{19})^*) = 0$	504
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23}) = (b_{20}')^{(3)}(b_{21}')^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23}) + (b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right] + (b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23}) = 0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^* such that $\varphi((G_{23})^*) = 0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27}) = (b_{24}')^{(4)}(b_{25}')^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27}) + (b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right] + (b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27}) = 0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^* such that $\varphi((G_{27})^*) = 0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31}) = (b_{28}')^{(5)}(b_{29}')^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31}) + (b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right] + (b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31}) = 0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^* such that $\varphi((G_{31})^*) = 0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35}) = (b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35}) + (b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right] + (b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35}) = 0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^* such that $\varphi(G_{35}{}^*) = 0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39}) = (b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39}) + (b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right] + (b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39}) = 0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G_{37}^* such that $\varphi(G_{39}{}^*) = 0$	509

By the same argument, the equations admit solutions G_{40}, G_{41} if $\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right] + (b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42})$, G_{40}, G_{42} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{41}^* such that $\varphi(G_{43}{}^*) = 0$	510
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right] + (b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46})$, G_{44}, G_{46} must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{45}^* such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G_{14}^* given by $\varphi(G^*) = 0$, T_{14}^* given by $f(T_{14}^*) = 0$ and $G_{13}^* = \frac{(a_{13})^{(1)}G_{14}^*}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14}^*)]}$, $G_{15}^* = \frac{(a_{15})^{(1)}G_{14}^*}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14}^*)]}$ $T_{13}^* = \frac{(b_{13})^{(1)}T_{14}^*}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T_{15}^* = \frac{(b_{15})^{(1)}T_{14}^*}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G_{17}^* given by $\varphi((G_{19})^*) = 0$, T_{17}^* given by $f(T_{17}^*) = 0$ and	512
$G_{16}^* = \frac{(a_{16})^{(2)}G_{17}^*}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17}^*)]}$, $G_{18}^* = \frac{(a_{18})^{(2)}G_{17}^*}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17}^*)]}$	513
$T_{16}^* = \frac{(b_{16})^{(2)}T_{17}^*}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T_{18}^* = \frac{(b_{18})^{(2)}T_{17}^*}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G_{21}^* given by $\varphi((G_{23})^*) = 0$, T_{21}^* given by $f(T_{21}^*) = 0$ and $G_{20}^* = \frac{(a_{20})^{(3)}G_{21}^*}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21}^*)]}$, $G_{22}^* = \frac{(a_{22})^{(3)}G_{21}^*}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T_{21}^*)]}$ $T_{20}^* = \frac{(b_{20})^{(3)}T_{21}^*}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T_{22}^* = \frac{(b_{22})^{(3)}T_{21}^*}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$	515

Obviously, these values represent an equilibrium solution of global equations	
Finally we obtain the unique solution G_{25}^{*} given by $\varphi(G_{27}) = 0$, T_{25}^{*} given by $f(T_{25}^{*}) = 0$ and $G_{24}^{*} = \frac{(a_{24})^{(4)} G_{25}^{*}}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26}^{*} = \frac{(a_{26})^{(4)} G_{25}^{*}}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^{*})]}$	516
$T_{24}^{*} = \frac{(b_{24})^{(4)} T_{25}^{*}}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^{*})]}$, $T_{26}^{*} = \frac{(b_{26})^{(4)} T_{25}^{*}}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^{*} given by $\varphi((G_{31})^{*}) = 0$, T_{29}^{*} given by $f(T_{29}^{*}) = 0$ and $G_{28}^{*} = \frac{(a_{28})^{(5)} G_{29}^{*}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*} = \frac{(a_{30})^{(5)} G_{29}^{*}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$	518
$T_{28}^{*} = \frac{(b_{28})^{(5)} T_{29}^{*}}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*} = \frac{(b_{30})^{(5)} T_{29}^{*}}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^{*} given by $\varphi((G_{35})^{*}) = 0$, T_{33}^{*} given by $f(T_{33}^{*}) = 0$ and $G_{32}^{*} = \frac{(a_{32})^{(6)} G_{33}^{*}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*} = \frac{(a_{34})^{(6)} G_{33}^{*}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$	520
$T_{32}^{*} = \frac{(b_{32})^{(6)} T_{33}^{*}}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^{*})]}$, $T_{34}^{*} = \frac{(b_{34})^{(6)} T_{33}^{*}}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^{*})]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^{*} given by $\varphi((G_{39})^{*}) = 0$, T_{37}^{*} given by $f(T_{37}^{*}) = 0$ and $G_{36}^{*} = \frac{(a_{36})^{(7)} G_{37}^{*}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]}$, $G_{38}^{*} = \frac{(a_{38})^{(7)} G_{37}^{*}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$ $T_{36}^{*} = \frac{(b_{36})^{(7)} T_{37}^{*}}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^{*})]}$, $T_{38}^{*} = \frac{(b_{38})^{(7)} T_{37}^{*}}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^{*})]}$	522
Finally we obtain the unique solution G_{41}^{*} given by $\varphi((G_{43})^{*}) = 0$, T_{41}^{*} given by $f(T_{41}^{*}) = 0$ and	523

$G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^*)]}$ $T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote <u>**Definition of**</u> $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^* \mathbb{G}_j\right)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^* \mathbb{G}_j\right)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^* \mathbb{G}_j\right)$	530
ASYMPTOTIC STABILITY ANALYSIS	531

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543

$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right)$	544
$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}$ *and* $(b_i^{''})^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^{*}) = (q_{25})^{(4)} \quad , \frac{\partial (b_i^{''})^{(4)}}{\partial G_j}((G_{27})^{*}) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^{*}\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}^{'})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^{*}\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^{*}\mathbb{G}_j\right)$	554
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Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^{*} + \mathbb{G}_i \quad , T_i = T_i^{*} + \mathbb{T}_i$ $\frac{\partial (a_{29}^{''})^{(5)}}{\partial T_{29}}(T_{29}^{*}) = (q_{29})^{(5)} \quad , \frac{\partial (b_i^{''})^{(5)}}{\partial G_j}(\,(G_{31})^{*}\,) = s_{ij}$	556

Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{28}}{dt} = -\left((a_{28}')^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G_{28}^*\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a_{29}')^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G_{29}^*\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a_{30}')^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G_{30}^*\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b_{28}')^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T_{28}^*\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b_{29}')^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T_{29}^*\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b_{30}')^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T_{30}^*\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(6)}$ *and* $(b_i'')^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{33}'')^{(6)}}{\partial T_{33}}(T_{33}^*) = (q_{33})^{(6)} \quad , \frac{\partial (b_i'')^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a_{32}')^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G_{32}^*\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a_{33}')^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G_{33}^*\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a_{34}')^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G_{34}^*\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b_{32}')^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T_{32}^*\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b_{33}')^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T_{33}^*\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b_{34}')^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T_{34}^*\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(7)}$ *and* $(b_i'')^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.	571

Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}}(T_{37}^*) = (q_{37})^{(7)} \quad , \frac{\partial (b_i'')^{(7)}}{\partial G_j}\left((G_{39})^{**} \right) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G_{36}^*\mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G_{37}^*\mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G_{38}^*\mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T_{36}^*\mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T_{37}^*\mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^*\mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}}(T_{41}^*) = (q_{41})^{(8)} \quad , \frac{\partial (b_i'')^{(8)}}{\partial G_j}\left((G_{43})^{*} \right) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^*\mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^*\mathbb{T}_{41}$	582

$\frac{d\mathbb{G}_{42}}{dt} = -\left((a'_{42})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^*\mathbb{T}_{41}$	583
$\frac{d\mathbb{T}_{40}}{dt} = -\left((b'_{40})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^*\mathbb{G}_j\right)$	584
$\frac{d\mathbb{T}_{41}}{dt} = -\left((b'_{41})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^*\mathbb{G}_j\right)$	585
$\frac{d\mathbb{T}_{42}}{dt} = -\left((b'_{42})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^*\mathbb{G}_j\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(9)}$ *and* $(b''_i)^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof: Denote**	586 A
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial(a''_{45})^{(9)}}{\partial T_{45}}(T_{45}^*) = (q_{45})^{(9)} \quad , \frac{\partial(b''_i)^{(9)}}{\partial G_j}\left((G_{47})^*\right) = s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt} = -\left((a'_{44})^{(9)} + (p_{44})^{(9)}\right)\mathbb{G}_{44} + (a_{44})^{(9)}\mathbb{G}_{45} - (q_{44})^{(9)}G_{44}^*\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt} = -\left((a'_{45})^{(9)} + (p_{45})^{(9)}\right)\mathbb{G}_{45} + (a_{45})^{(9)}\mathbb{G}_{44} - (q_{45})^{(9)}G_{45}^*\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt} = -\left((a'_{46})^{(9)} + (p_{46})^{(9)}\right)\mathbb{G}_{46} + (a_{46})^{(9)}\mathbb{G}_{45} - (q_{46})^{(9)}G_{46}^*\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt} = -\left((b'_{44})^{(9)} - (r_{44})^{(9)}\right)\mathbb{T}_{44} + (b_{44})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^*\mathbb{G}_j\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt} = -\left((b'_{45})^{(9)} - (r_{45})^{(9)}\right)\mathbb{T}_{45} + (b_{45})^{(9)}\mathbb{T}_{44} + \sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^*\mathbb{G}_j\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt} = -\left((b'_{46})^{(9)} - (r_{46})^{(9)}\right)\mathbb{T}_{46} + (b_{46})^{(9)}\mathbb{T}_{45} + \sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^*\mathbb{G}_j\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)} + (b'_{15})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a'_{15})^{(1)} + (p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)} + (a'_{13})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^*\right)\right]$ $\left(\left((\lambda)^{(1)} + (b'_{13})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^* + (b_{14})^{(1)}s_{(13),(14)}T_{14}^*\right)$	

$+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$\left(\left((\lambda)^{(1)}\right)^{2}+\left((b_{13}^{'})^{(1)}+(b_{14}^{'})^{(1)}-(r_{13})^{(1)}+(r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$

$+\left(\left((\lambda)^{(1)}\right)^{2}+\left((a_{13}^{'})^{(1)}+(a_{14}^{'})^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$

$+\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)$

$\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(15)}T_{13}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(2)}+(b_{18}^{'})^{(2)}-(r_{18})^{(2)}\right)\{\left((\lambda)^{(2)}+(a_{18}^{'})^{(2)}+(p_{18})^{(2)}\right)$

$\left[\left(\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)\right]$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(17)}T_{17}^{*}\right)$

$+\left(\left((\lambda)^{(2)}+(a_{17}^{'})^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}G_{16}^{*}+(a_{16})^{(2)}(q_{17})^{(2)}G_{17}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(16)}T_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$\left(\left((\lambda)^{(2)}\right)^{2}+\left((b_{16}^{'})^{(2)}+(b_{17}^{'})^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\right)$

$+\left(\left((\lambda)^{(2)}\right)^{2}+\left((a_{16}^{'})^{(2)}+(a_{17}^{'})^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\right)(q_{18})^{(2)}G_{18}$

$+\left((\lambda)^{(2)}+(a_{16}^{'})^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}G_{17}^{*}+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}G_{16}^{*}\right)$

$\left(\left((\lambda)^{(2)}+(b_{16}^{'})^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}T_{17}^{*}+(b_{17})^{(2)}s_{(16),(18)}T_{16}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(3)}+(b_{22}^{'})^{(3)}-(r_{22})^{(3)}\right)\{\left((\lambda)^{(3)}+(a_{22}^{'})^{(3)}+(p_{22})^{(3)}\right)$

$\left[\left(\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)\right]$

$\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(21)}T_{21}^{*}\right)$

$+\left(\left((\lambda)^{(3)}+(a_{21}^{'})^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^{*}+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(20)}T_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^{2}+\left((b_{20}^{'})^{(3)}+(b_{21}^{'})^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^{2}+\left((a_{20}^{'})^{(3)}+(a_{21}^{'})^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+\left((\lambda)^{(3)}+(a_{20}^{'})^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*}+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)}+(b_{20}^{'})^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*}+(b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\}=0$ +	
$\left((\lambda)^{(4)}+(b_{26}^{'})^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a_{26}^{'})^{(4)}+(p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)}+(a_{25}^{'})^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*}+(a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^{2}+\left((b_{24}^{'})^{(4)}+(b_{25}^{'})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a_{24}^{'})^{(4)}+(a_{25}^{'})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+\left((\lambda)^{(4)}+(a_{24}^{'})^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}+(b_{24}^{'})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*}+(b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\}=0$ +	
$\left((\lambda)^{(5)}+(b_{30}^{'})^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a_{30}^{'})^{(5)}+(p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$	

$$+\left(\left((\lambda)^{(5)}+(a_{29}^{'})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*}+(a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a_{28}^{'})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G_{29}^{*}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)$$

$$\left(\left((\lambda)^{(5)}+(b_{28}^{'})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T_{29}^{*}+(b_{29})^{(5)}s_{(28),(30)}T_{28}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(6)}+(b_{34}^{'})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a_{34}^{'})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(33)}T_{33}^{*}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a_{33}^{'})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G_{32}^{*}+(a_{32})^{(6)}(q_{33})^{(6)}G_{33}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(32)}T_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b_{32}^{'})^{(6)}+(b_{33}^{'})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a_{32}^{'})^{(6)}+(a_{33}^{'})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a_{32}^{'})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G_{33}^{*}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G_{32}^{*}\right)$$

$$\left(\left((\lambda)^{(6)}+(b_{32}^{'})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T_{33}^{*}+(b_{33})^{(6)}s_{(32),(34)}T_{32}^{*}\right)\}=0$$

$+$

$$\left((\lambda)^{(7)}+(b_{38}^{'})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a_{38}^{'})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a_{36}^{'})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b_{36}^{'})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(37)}T_{37}^{*}\right)$$

$+\left(\left((\lambda)^{(7)}+(a_{37}')^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G_{36}^{*}+(a_{36})^{(7)}(q_{37})^{(7)}G_{37}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(36)}T_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b_{36}')^{(7)}+(b_{37}')^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$

$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a_{36}')^{(7)}+(a_{37}')^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$

$+\left((\lambda)^{(7)}+(a_{36}')^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G_{37}^{*}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G_{36}^{*}\right)$

$\left(\left((\lambda)^{(7)}+(b_{36}')^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T_{37}^{*}+(b_{37})^{(7)}s_{(36),(38)}T_{36}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(8)}+(b_{42}')^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a_{42}')^{(8)}+(p_{42})^{(8)}\right)$

$\left[\left(\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)\right]$

$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(41)}T_{41}^{*}\right)$

$+\left(\left((\lambda)^{(8)}+(a_{41}')^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G_{40}^{*}+(a_{40})^{(8)}(q_{41})^{(8)}G_{41}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(40)}T_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$\left(\left((\lambda)^{(8)}\right)^{2}+\left((b_{40}')^{(8)}+(b_{41}')^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$

$+\left(\left((\lambda)^{(8)}\right)^{2}+\left((a_{40}')^{(8)}+(a_{41}')^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$

$+\left((\lambda)^{(8)}+(a_{40}')^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G_{41}^{*}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G_{40}^{*}\right)$

$\left(\left((\lambda)^{(8)}+(b_{40}')^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T_{41}^{*}+(b_{41})^{(8)}s_{(40),(42)}T_{40}^{*}\right)\}=0$

$+$

$\left((\lambda)^{(9)}+(b_{46}')^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a_{46}')^{(9)}+(p_{46})^{(9)}\right)$

$\left[\left(\left((\lambda)^{(9)}+(a_{44}')^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)\right]$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(45)}T_{45}^{*}\right)$

$+\left(\left((\lambda)^{(9)}+(a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G_{44}^{*}+(a_{44})^{(9)}(q_{45})^{(9)}G_{45}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future.**

SECTION THIRTY SEVEN

Alignment Limit In Two-Higgs-Doublet Models

INTRODUCTION—VARIABLES USED

Scrutinizing the Alignment Limit in Two-Higgs-Doublet Models. Part 1: mh=125 GeV Jérémy Bernon, John F. Gunion, Howard E. Haber, Yun Jiang, Sabine Kraml

(1) In the alignment limit of a multi-doublet Higgs sector, one of the Higgs mass eigenstates aligns with (e&eb) the direction of the scalar field vacuum expectation values, and its couplings approach (e&eb) those of the Standard Model (SM) Higgs boson.
(2) Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of (e)Type I and Type II near (eb) the alignment limit in which the lighter of the two CP-even Higgs bosons, h, is (=) the SM-like state observed at 125 GeV
(3) In particular, authors focus on the 2HDM parameter regime where (e) the coupling of h to (e&eb) gauge bosons approaches (eb) that of the SM.
(4) They review the theoretical structure and analyze the phenomenological implications of the regime of

alignment limit without (e) decoupling, in which the other Higgs scalar masses are not (e) significantly larger than mh and thus do not decouple from (e) the effective theory at the electroweak scale.

(5) For the numerical analysis, authors perform scans of (e &eb)) the 2HDM parameter space employing (e) the software packages 2HDMC and Lilith, taking into account (e) all relevant pre-LHC constraints, the latest constraints from (e) the measurements of the 125 GeV Higgs signal at (eb) the LHC, as well as the most recent limits coming from (e) searches for heavy Higgs-like states.

(6) Authors contrast these results with (e&eb) the alignment limit achieved via (e&eb) the decoupling of heavier scalar states, where (e) h is the only light Higgs scalar.

(7) Implications for Run 2 at the LHC, including expectations for (e) observing the other scalar states, are also discussed. Subjects: High Energy Physics - Phenomenology (hep-ph) Journal reference: Phys. Rev. D 92, 075004 (2015) DOI: 10.1103/PhysRevD.92.075004 Cite as: arXiv: 1507.00933 [hep-ph] (or arXiv: 1507.00933v3 [hep-ph] for this version)

Preserving the validity of the Two-Higgs Doublet Model up to the Planck scale Pedro Ferreira, Howard E. Haber, Edward Santos

We examine the constraints on the two Higgs doublet model (2HDM) due to the stability of the scalar potential and absence of Landau poles at energy scales below the Planck scale. We employ the most general 2HDM that incorporates an approximately Standard Model (SM) Higgs boson with a flavor aligned Yukawa sector to eliminate potential tree-level Higgs-mediated flavor changing neutral currents. Using basis independent techniques, we exhibit robust regimes of the 2HDM parameter space with a 125 GeV SM-like Higgs boson that is stable and perturbative up to the Planck scale. Implications for the heavy scalar spectrum are exhibited. Subjects: High Energy Physics - Phenomenology (hep-ph) Journal reference: Phys. Rev. D 92, 033003 (2015) DOI: 10.1103/PhysRevD.92.033003 Report number: SCIPP-15/07 Cite as: arXiv:1505.04001 [hep-ph] (or arXiv:1505.04001v2 [hep-ph] for this version)

NOTATION

Module One

one of the Higgs mass eigenstates in the alignment limit of a multi-doublet Higgs sector aligns with (e&eb) the direction of the scalar field vacuum expectation values, and its couplings approach (e&eb) those of the Standard Model (SM) Higgs boson

G_{13} : Category one of **one of the Higgs mass eigenstates in the alignment limit of a multi-doublet Higgs sector aligns;** direction of the scalar field vacuum expectation values, and its couplings approach (e&eb) those of the Standard Model (SM) Higgs boson

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of direction of the scalar field vacuum expectation values, and its couplings approach (e&eb) those of the Standard Model (SM) Higgs boson; **one of the Higgs mass eigenstates in the alignment limit of a multi-doublet Higgs sector aligns**

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

one of the Higgs mass eigenstates in the alignment limit of a multi-doublet Higgs sector aligns with the

direction of the scalar field vacuum expectation values, and its couplings approach (e&eb) those of the Standard Model (SM) Higgs boson	
G_{16} : Category one of **Higgs mass eigenstates in the alignment limit of a multi-doublet Higgs sector aligns with the direction of the scalar field vacuum expectation values, and its couplings;** those of the Standard Model (SM) Higgs boson G_{17} : Category two of SAS G_{18} : Category three of SAS	
T_{16} : Category one of those of the Standard Model (SM) Higgs boson **;Higgs mass eigenstates in the alignment limit of a multi-doublet Higgs sector aligns with the direction of the scalar field vacuum expectation values, and its couplings** T_{17} : Category two of SAS T_{18} : Category three of SAS	
Module three Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of (e)Type I and Type II near (eb) the alignment limit in which the lighter of the two CP-even Higgs bosons, h, is (=) the SM-like state observed at 125 GeV	
G_{20} : Category one of **CP-conserving Two-Higgs-Doublet Models (2HDMs);** Type I and Type II near (eb) the alignment limit in which the lighter of the two CP-even Higgs bosons, h, is (=) the SM-like state observed at 125 GeV G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one of Type I and Type II near (eb) the alignment limit in which the lighter of the two CP-even Higgs bosons, h, is (=) the SM-like state observed at 125 GeV **;CP-conserving Two-Higgs-Doublet Models (2HDMs)** T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four Authors consider CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II near (eb) the alignment limit in which the lighter of the two CP-even Higgs bosons, h, is (=) the SM-like state observed at 125 GeV	
G_{24} : Category one of CP-conserving Two-Higgs-Doublet Models (2HDMs) of Type I and Type II G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of alignment limit in which the lighter of the two CP-even Higgs bosons, h, is (=) the SM-like state observed at 125 GeV	

T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five In particular, authors focus on the 2HDM parameter regime where (e) the coupling of h to (e&eb) gauge bosons approaches (eb) that of the SM	
G_{28} : Category one of coupling of h to (e&eb) gauge bosons approaches (eb) that of the SM G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of2HDM parameter regime T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six In particular, authors focus on the 2HDM parameter regime where the coupling of h to (e&eb) gauge bosons approaches (eb) that of the SM	
G_{32} : Category one of**2HDM parameter regime where the coupling of h;** gauge bosons approaches (eb) that of the SM G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of gauge bosons approaches (eb) that of the SM **;2HDM parameter regime where the coupling of h** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven In particular, authors focus on the 2HDM parameter regime where the coupling of h to gauge bosons approaches (eb) that of the SM	
G_{36} : Category one of2HDM parameter regime where the coupling of h to gauge bosons approaches G_{37} : Category two of SAS G_{38} : Category three of SAS	

T_{36} : Category one of parameter regime of the SM T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight They review the theoretical structure and analyze the phenomenological implications of the regime of alignment limit without (e) decoupling, in which the other Higgs scalar masses are not (e) significantly larger than mh and thus do not decouple from (e) the effective theory at the electroweak scale	
G_{40} : Category one of effective theory at the electroweak scale G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of regime of alignment limit without (e) decoupling, in which the other Higgs scalar masses are not (e) significantly larger than mh and thus do not decouple from T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine For the numerical analysis, authors perform scans of the 2HDM parameter space employing (e) the software packages 2HDMC and Lilith, taking into account (e) all relevant pre-LHC constraints, the latest constraints from (e) the measurements of the 125 GeV Higgs signal at (eb) the LHC, as well as the most recent limits coming from (e) searches for heavy Higgs-like states	
G_{44} : Category one ofsoftware packages 2HDMC and Lilith, taking into account (e) all relevant pre-LHC constraints, the latest constraints from (e) the measurements of the 125 GeV Higgs signal at (eb) the LHC, as well as the most recent limits coming from (e) searches for heavy Higgs-like states G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of scans of the 2HDM parameter space T_{45} : Category two of SAS T_{46} : Category three of SAS	
The Coefficients:	
$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}$ $(a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$ $(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}$: $(a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}$, $(b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$ $(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)}, (a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}$, $(a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$	

$(a_{36})^{(7)},(a_{37})^{(7)},(a_{38})^{(7)},(b_{36})^{(7)},(b_{37})^{(7)},(b_{38})^{(7)}$ $(a_{40})^{(8)},(a_{41})^{(8)},(a_{42})^{(8)},(b_{40})^{(8)},(b_{41})^{(8)},(b_{42})^{(8)}$ $(a_{44})^{(9)},(a_{45})^{(9)},(a_{46})^{(9)},(b_{44})^{(9)},(b_{45})^{(9)},(b_{46})^{(9)}$ are Accentuation coefficients $(a'_{13})^{(1)},(a'_{14})^{(1)},(a'_{15})^{(1)},(b'_{13})^{(1)},(b'_{14})^{(1)},(b'_{15})^{(1)},(a'_{16})^{(2)},(a'_{17})^{(2)},(a'_{18})^{(2)},\ (b'_{16})^{(2)},(b'_{17})^{(2)},(b'_{18})^{(2)}$ $,(a'_{20})^{(3)},(a'_{21})^{(3)},(a'_{22})^{(3)},(b'_{20})^{(3)},(b'_{21})^{(3)},(b'_{22})^{(3)}$ $(a'_{24})^{(4)},(a'_{25})^{(4)},(a'_{26})^{(4)},(b'_{24})^{(4)},(b'_{25})^{(4)},(b'_{26})^{(4)},(b'_{28})^{(5)},(b'_{29})^{(5)},(b'_{30})^{(5)}\ (a'_{28})^{(5)},(a'_{29})^{(5)},(a'_{30})^{(5)}$, $(a'_{32})^{(6)},(a'_{33})^{(6)},(a'_{34})^{(6)},(b'_{32})^{(6)},(b'_{33})^{(6)},(b'_{34})^{(6)}$ $(a'_{36})^{(7)},(a'_{37})^{(7)},(a'_{38})^{(7)},(b'_{36})^{(7)},(b'_{37})^{(7)},(b'_{38})^{(7)}$, $(a'_{40})^{(8)},(a'_{41})^{(8)},(a'_{42})^{(8)},(b'_{40})^{(8)},(b'_{41})^{(8)},(b'_{42})^{(8)}$, $(a'_{44})^{(9)},(a'_{45})^{(9)},(a'_{46})^{(9)},(b'_{44})^{(9)},(b'_{45})^{(9)},(b'_{46})^{(9)}$, are Dissipation coefficients	
Module Numbered One **The differential system of this model is now (Module Numbered one)**	
$\frac{dG_{13}}{dt}=(a_{13})^{(1)}G_{14}-\left[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T_{14},t)\right]G_{13}$	1
$\frac{dG_{14}}{dt}=(a_{14})^{(1)}G_{13}-\left[(a'_{14})^{(1)}+(a''_{14})^{(1)}(T_{14},t)\right]G_{14}$	2
$\frac{dG_{15}}{dt}=(a_{15})^{(1)}G_{14}-\left[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T_{14},t)\right]G_{15}$	3
$\frac{dT_{13}}{dt}=(b_{13})^{(1)}T_{14}-\left[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G,t)\right]T_{13}$	4
$\frac{dT_{14}}{dt}=(b_{14})^{(1)}T_{13}-\left[(b'_{14})^{(1)}-(b''_{14})^{(1)}(G,t)\right]T_{14}$	5
$\frac{dT_{15}}{dt}=(b_{15})^{(1)}T_{14}-\left[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G,t)\right]T_{15}$	6
$+(a''_{13})^{(1)}(T_{14},t)=$ First augmentation factor	
$-(b''_{13})^{(1)}(G,t)=$ First detritions factor	
Module Numbered Two **The differential system of this model is now (Module numbered two)**	
$\frac{dG_{16}}{dt}=(a_{16})^{(2)}G_{17}-\left[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T_{17},t)\right]G_{16}$	7
$\frac{dG_{17}}{dt}=(a_{17})^{(2)}G_{16}-\left[(a'_{17})^{(2)}+(a''_{17})^{(2)}(T_{17},t)\right]G_{17}$	8
$\frac{dG_{18}}{dt}=(a_{18})^{(2)}G_{17}-\left[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T_{17},t)\right]G_{18}$	9
$\frac{dT_{16}}{dt}=(b_{16})^{(2)}T_{17}-\left[(b'_{16})^{(2)}-(b''_{16})^{(2)}\left((G_{19}),t\right)\right]T_{16}$	10
$\frac{dT_{17}}{dt}=(b_{17})^{(2)}T_{16}-\left[(b'_{17})^{(2)}-(b''_{17})^{(2)}\left((G_{19}),t\right)\right]T_{17}$	11
$\frac{dT_{18}}{dt}=(b_{18})^{(2)}T_{17}-\left[(b'_{18})^{(2)}-(b''_{18})^{(2)}\left((G_{19}),t\right)\right]T_{18}$	12
$+(a''_{16})^{(2)}(T_{17},t)=$ First augmentation factor	
$-(b''_{16})^{(2)}\left((G_{19}),t\right)=$ First detritions factor	
Module Numbered Three **The differential system of this model is now (Module numbered three)**	
$\frac{dG_{20}}{dt}=(a_{20})^{(3)}G_{21}-\left[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T_{21},t)\right]G_{20}$	13

$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21}$	14
$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22}$	15
$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20}$	16
$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21}$	17
$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22}$	18
$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor	
$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor	
Module Numbered Four **The differential system of this model is now (Module numbered Four)**	
$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24}$	19
$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25}$	20
$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25},t)\right]G_{26}$	21
$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{24}$	22
$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{25}$	23
$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\left((G_{27}),t\right)\right]T_{26}$	24
$+(a_{24}^{''})^{(4)}(T_{25},t) =$ **First augmentation factor**	
$-(b_{24}^{''})^{(4)}\left((G_{27}),t\right) =$ **First detritions factor**	
Module Numbered Five: **The differential system of this model is now (Module number five)**	
$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right]G_{28}$	25
$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29},t)\right]G_{29}$	26
$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29},t)\right]G_{30}$	27
$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{28}$	28
$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{29}$	29
$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}\left((G_{31}),t\right)\right]T_{30}$	30
$+(a_{28}^{''})^{(5)}(T_{29},t) =$ **First augmentation factor**	
$-(b_{28}^{''})^{(5)}\left((G_{31}),t\right) =$ **First detritions factor**	
Module Numbered Six **The differential system of this model is now (Module numbered Six)**	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33},t)\right]G_{32}$	31
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33},t)\right]G_{33}$	32
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33},t)\right]G_{34}$	33
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{32}$	34
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{33}$	35

$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}\left((G_{35}),t\right)\right]T_{34}$	36
$+(a_{32}^{''})^{(6)}(T_{33},t) =$ **First augmentation factor**	
Module Numbered Seven: **The differential system of this model is now (Seventh Module)**	
$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t)\right]G_{36}$	37
$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t)\right]G_{37}$	38
$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t)\right]G_{38}$	39
$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{36}$	40
$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{37}$	41
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}\left((G_{39}),t\right)\right]T_{38}$	42
$+(a_{36}^{''})^{(7)}(T_{37},t) =$ **First augmentation factor**	
Module Numbered Eight The differential system of this model is now	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41},t)\right]G_{40}$	43
$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(8)}(T_{41},t)\right]G_{41}$	44
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41},t)\right]G_{42}$	45
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{40}$	46
$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{41}$	47
$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}\left((G_{43}),t\right)\right]T_{42}$	48
Module Numbered Nine The differential system of this model is now	
$\frac{dG_{44}}{dt} = (a_{44})^{(9)}G_{45} - \left[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45},t)\right]G_{44}$	49
$\frac{dG_{45}}{dt} = (a_{45})^{(9)}G_{44} - \left[(a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)}(T_{45},t)\right]G_{45}$	50
$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \left[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45},t)\right]G_{46}$	51
$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \left[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{44}$	52
$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \left[(b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{45}$	53
$\frac{dT_{46}}{dt} = (b_{46})^{(9)}T_{45} - \left[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}\left((G_{47}),t\right)\right]T_{46}$	54
$+(a_{44}^{''})^{(9)}(T_{45},t) =$ **First augmentation factor**	
$-(b_{44}^{''})^{(9)}\left((G_{47}),t\right) =$ **First detrition factor**	
$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \begin{bmatrix} (a_{13}^{'})^{(1)} \boxed{+(a_{13}^{''})^{(1)}(T_{14},t)} \boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)} \boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7,7)}(T_{37},t)} \boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)} \boxed{+(a_{44}^{''})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	55

$$\frac{dG_{14}}{dt} = (a_{14})^{(1)} G_{13} - \left[\begin{matrix} (a'_{14})^{(1)} \boxed{+(a''_{14})^{(1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{14}$$ *56*

$$\frac{dG_{15}}{dt} = (a_{15})^{(1)} G_{14} - \left[\begin{matrix} (a'_{15})^{(1)} \boxed{+(a''_{15})^{(1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{15}$$ *57*

Where $\boxed{(a''_{13})^{(1)}(T_{14},t)}$, $\boxed{(a''_{14})^{(1)}(T_{14},t)}$, $\boxed{(a''_{15})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7)}(T_{37},t)}$ are seventh augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{41})^{(8,8)}(T_{41},t)}$ $\boxed{+(a''_{42})^{(8,8)}(T_{41},t)}$ are eight augmentation coefficient for 1,2,3

$\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)} T_{14} - \left[\begin{matrix} (b'_{13})^{(1)} \boxed{-(b''_{13})^{(1)}(G,t)} \boxed{-(b''_{16})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{13}$$ 58

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)} T_{13} - \left[\begin{matrix} (b'_{14})^{(1)} \boxed{-(b''_{14})^{(1)}(G,t)} \boxed{-(b''_{17})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{14}$$ 59

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)} T_{14} - \left[\begin{matrix} (b'_{15})^{(1)} \boxed{-(b''_{15})^{(1)}(G,t)} \boxed{-(b''_{18})^{(2,2,)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{matrix} \right] T_{15}$$ *60*

Where $\boxed{-(b''_{13})^{(1)}(G,t)}$, $\boxed{-(b''_{14})^{(1)}(G,t)}$, $\boxed{-(b''_{15})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,)}(G_{19},t)}$ are second detrition coefficients for

category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{41})^{(8,8)}(G_{43},t)}$ $\boxed{-(b''_{42})^{(8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{matrix} (a'_{16})^{(2)} \boxed{+(a''_{16})^{(2)}(T_{17},t)} \boxed{+(a''_{13})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{36})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{16}$	*61*
$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{matrix} (a'_{17})^{(2)} \boxed{+(a''_{17})^{(2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{17}$	*62*
$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{matrix} (a'_{18})^{(2)} \boxed{+(a''_{18})^{(2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,)}(T_{14},t)} \boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9)}(T_{45},t)} \end{matrix}\right] G_{18}$	*63*
Where $\boxed{+(a''_{16})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3	

$+(a''_{36})^{(7,7,7)}(T_{37},t)$, $+(a''_{37})^{(7,7,7)}(T_{37},t)$, $+(a''_{38})^{(7,7,7)}(T_{37},t)$ are seventh augmentation coefficient for category 1, 2 and 3 $+(a''_{40})^{(8,8,8)}(T_{41},t)$, $+(a''_{41})^{(8,8,8)}(T_{41},t)$, $+(a''_{42})^{(8,8,8)}(T_{41},t)$ are eight augmentation coefficient for category 1, 2 and 3 $+(a''_{44})^{(9,9)}(T_{45},t)$, $+(a''_{45})^{(9,9)}(T_{45},t)$, $+(a''_{46})^{(9,9)}(T_{45},t)$ are ninth augmentation coefficient for category 1, 2 and 3	
$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{matrix} (b'_{16})^{(2)} -(b''_{16})^{(2)}(G_{19},t) -(b''_{13})^{(1,1,)}(G,t) -(b''_{20})^{(3,3,3,)}(G_{23},t) \\ -(b''_{24})^{(4,4,4,4,4)}(G_{27},t) -(b''_{28})^{(5,5,5,5,5)}(G_{31},t) -(b''_{32})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{36})^{(7,7,7)}(G_{39},t) -(b''_{40})^{(8,8,8)}(G_{43},t) -(b''_{44})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{16}$	64
$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{matrix} (b'_{17})^{(2)} -(b''_{17})^{(2)}(G_{19},t) -(b''_{14})^{(1,1,)}(G,t) -(b''_{21})^{(3,3,3,)}(G_{23},t) \\ -(b''_{25})^{(4,4,4,4,4)}(G_{27},t) -(b''_{29})^{(5,5,5,5,5)}(G_{31},t) -(b''_{33})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{37})^{(7,7,7)}(G_{39},t) -(b''_{41})^{(8,8,8)}(G_{43},t) -(b''_{45})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{17}$	65
$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{matrix} (b'_{18})^{(2)} -(b''_{18})^{(2)}(G_{19},t) -(b''_{15})^{(1,1,)}(G,t) -(b''_{22})^{(3,3,3,)}(G_{23},t) \\ -(b''_{26})^{(4,4,4,4,4)}(G_{27},t) -(b''_{30})^{(5,5,5,5,5)}(G_{31},t) -(b''_{34})^{(6,6,6,6,6)}(G_{35},t) \\ -(b''_{38})^{(7,7,7)}(G_{39},t) -(b''_{42})^{(8,8,8)}(G_{43},t) -(b''_{46})^{(9,9)}(G_{47},t) \end{matrix} \right] T_{18}$	66
where $-(b''_{16})^{(2)}(G_{19},t)$, $-(b''_{17})^{(2)}(G_{19},t)$, $-(b''_{18})^{(2)}(G_{19},t)$ are first detrition coefficients for category 1, 2 and 3 $-(b''_{13})^{(1,1,)}(G,t)$, $-(b''_{14})^{(1,1,)}(G,t)$, $-(b''_{15})^{(1,1,)}(G,t)$ are second detrition coefficients for category 1,2 and 3 $-(b''_{20})^{(3,3,3,)}(G_{23},t)$, $-(b''_{21})^{(3,3,3,)}(G_{23},t)$, $-(b''_{22})^{(3,3,3,)}(G_{23},t)$ are third detrition coefficients for category 1,2 and 3 $-(b''_{24})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{25})^{(4,4,4,4,4)}(G_{27},t)$, $-(b''_{26})^{(4,4,4,4,4)}(G_{27},t)$ are fourth detrition coefficients for category 1,2 and 3 $-(b''_{28})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{29})^{(5,5,5,5,5)}(G_{31},t)$, $-(b''_{30})^{(5,5,5,5,5)}(G_{31},t)$ are fifth detrition coefficients for category 1,2 and 3 $-(b''_{32})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{33})^{(6,6,6,6,6)}(G_{35},t)$, $-(b''_{34})^{(6,6,6,6,6)}(G_{35},t)$ are sixth detrition coefficients for category 1,2 and 3 $-(b''_{36})^{(7,7,7)}(G_{39},t)$, $-(b''_{37})^{(7,7,7)}(G_{39},t)$, $-(b''_{38})^{(7,7,7)}(G_{39},t)$ are seventh detrition coefficients for category 1,2 and 3 $-(b''_{40})^{(8,8,8)}(G_{43},t)$, $-(b''_{41})^{(8,8,8)}(G_{43},t)$, $-(b''_{42})^{(8,8,8)}(G_{43},t)$ are eight detrition coefficients for category 1,2 and 3 $-(b''_{44})^{(9,9)}(G_{47},t)$, $-(b''_{46})^{(9,9)}(G_{47},t)$, $-(b''_{45})^{(9,9)}(G_{47},t)$ are ninth detrition coefficients for category 1,2 and 3	
$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[\begin{matrix} (a'_{20})^{(3)} +(a''_{20})^{(3)}(T_{21},t) +(a''_{16})^{(2,2,2)}(T_{17},t) +(a''_{13})^{(1,1,1,)}(T_{14},t) \\ +(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t) +(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t) +(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t) \\ +(a''_{36})^{(7,7,7,7)}(T_{37},t) +(a''_{40})^{(8,8,8,8)}(T_{41},t) +(a''_{44})^{(9,9,9)}(T_{45},t) \end{matrix} \right] G_{20}$	67

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \begin{bmatrix} (a'_{21})^{(3)} \boxed{+(a''_{21})^{(3)}(T_{21},t)} \boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{21} \qquad 68$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \begin{bmatrix} (a'_{22})^{(3)} \boxed{+(a''_{22})^{(3)}(T_{21},t)} \boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)} \boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)} \end{bmatrix} G_{22} \qquad 69$$

$\boxed{+(a''_{20})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{36})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{40})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8)}(T_{41},t)}$ are eight augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{44})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1, 2 and 3

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \begin{bmatrix} (b'_{20})^{(3)} \boxed{-(b''_{20})^{(3)}(G_{23},t)} \boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{13})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{20} \qquad 70$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \begin{bmatrix} (b'_{21})^{(3)} \boxed{-(b''_{21})^{(3)}(G_{23},t)} \boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{14})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{21} \qquad 71$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \begin{bmatrix} (b'_{22})^{(3)} \boxed{-(b''_{22})^{(3)}(G_{23},t)} \boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)} \boxed{-(b''_{15})^{(1,1,1,)}(G,t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9)}(G_{47},t)} \end{bmatrix} T_{22} \qquad 72$$

$\boxed{-(b''_{20})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3)}(G_{23},t)}$ *are first detrition coefficients for category 1, 2 and 3*

$\boxed{-(b''_{16})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2)}(G_{19},t)}$ *are second detrition coefficients for*

category 1, 2 and 3

$\boxed{-(b_{13}'')^{(1,1,1,)}(G,t)}$, $\boxed{-(b_{14}'')^{(1,1,1,)}(G,t)}$, $\boxed{-(b_{15}'')^{(1,1,1,)}(G,t)}$ *are third detrition coefficients for category 1,2 and 3*

$\boxed{-(b_{24}'')^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{25}'')^{(4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b_{26}'')^{(4,4,4,4,4,4)}(G_{27},t)}$ *are fourth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{28}'')^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{29}'')^{(5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b_{30}'')^{(5,5,5,5,5,5)}(G_{31},t)}$ *are fifth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{32}'')^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{33}'')^{(6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b_{34}'')^{(6,6,6,6,6,6)}(G_{35},t)}$ *are sixth detrition coefficients for category 1, 2 and 3*

$\boxed{-(b_{36}'')^{(7,7,7,7)}(G_{39},t)}$, $\boxed{-(b_{37}'')^{(7,7,7,7)}(G_{39},t)}$ $\boxed{-(b_{38}'')^{(7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{40}'')^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{41}'')^{(8,8,8,8)}(G_{43},t)}$, $\boxed{-(b_{42}'')^{(8,8,8,8)}(G_{43},t)}$ are eight detrition coefficients for category 1, 2 and 3

$\boxed{-(b_{46}'')^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b_{45}'')^{(9,9,9)}(G_{47},t)}$, $\boxed{-(b_{44}'')^{(9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \begin{bmatrix} (a_{24}')^{(4)} \boxed{+(a_{24}'')^{(4)}(T_{25},t)} \boxed{+(a_{28}'')^{(5,5,)}(T_{29},t)} \boxed{+(a_{32}'')^{(6,6,)}(T_{33},t)} \\ \boxed{+(a_{13}'')^{(1,1,1,1)}(T_{14},t)} \boxed{+(a_{16}'')^{(2,2,2,2)}(T_{17},t)} \boxed{+(a_{20}'')^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}'')^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{40}'')^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{44}'')^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{24} \quad 73$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \begin{bmatrix} (a_{25}')^{(4)} \boxed{+(a_{25}'')^{(4)}(T_{25},t)} \boxed{+(a_{29}'')^{(5,5,)}(T_{29},t)} \boxed{+(a_{33}'')^{(6,6)}(T_{33},t)} \\ \boxed{+(a_{14}'')^{(1,1,1,1)}(T_{14},t)} \boxed{+(a_{17}'')^{(2,2,2,2)}(T_{17},t)} \boxed{+(a_{21}'')^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{37}'')^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{41}'')^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{45}'')^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{25} \quad 74$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \begin{bmatrix} (a_{26}')^{(4)} \boxed{+(a_{26}'')^{(4)}(T_{25},t)} \boxed{+(a_{30}'')^{(5,5,)}(T_{29},t)} \boxed{+(a_{34}'')^{(6,6,)}(T_{33},t)} \\ \boxed{+(a_{15}'')^{(1,1,1,1)}(T_{14},t)} \boxed{+(a_{18}'')^{(2,2,2,2)}(T_{17},t)} \boxed{+(a_{22}'')^{(3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}'')^{(7,7,7,7,7)}(T_{37},t)} \boxed{+(a_{42}'')^{(8,8,8,8,8)}(T_{41},t)} \boxed{+(a_{46}'')^{(9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{26} \quad 75$$

$\boxed{(a_{24}'')^{(4)}(T_{25},t)}$, $\boxed{(a_{25}'')^{(4)}(T_{25},t)}$, $\boxed{(a_{26}'')^{(4)}(T_{25},t)}$ $are\ first\ augmentation\ coefficients\ category\ 1, 2\ \ 3$

$\boxed{+(a_{28}'')^{(5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}'')^{(5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}'')^{(5,5,)}(T_{29},t)}$ $are\ second\ augmentation\ coefficient\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a_{32}'')^{(6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}'')^{(6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}'')^{(6,6,)}(T_{33},t)}$ $are\ third\ augmentation\ coefficient\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a_{13}'')^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}'')^{(1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}'')^{(1,1,1,1)}(T_{14},t)}$

$are\ fourth\ augmentation\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a_{16}'')^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}'')^{(2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}'')^{(2,2,2,2)}(T_{17},t)}$

$are\ fifth\ augmentation\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a_{20}'')^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}'')^{(3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}'')^{(3,3,3,3)}(T_{21},t)}$

$are\ sixth\ augmentation\ coefficients\ for\ category\ 1, 2\ and\ 3$

$\boxed{+(a_{36}'')^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{37}'')^{(7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a_{38}'')^{(7,7,7,7,7)}(T_{37},t)}$

are seventh augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{40})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8)}(T_{41},t)}$

are eighth augmentation coefficients for category 1, 2 *and* 3

$\boxed{+(a''_{46})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9)}(T_{45},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[\begin{matrix} (b'_{24})^{(4)}\boxed{-(b''_{24})^{(4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{24} \quad 76$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[\begin{matrix} (b'_{25})^{(4)}\boxed{-(b''_{25})^{(4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{25} \quad 77$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[\begin{matrix} (b'_{26})^{(4)}\boxed{-(b''_{26})^{(4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{26} \quad 78$$

Where $\boxed{-(b''_{24})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4)}(G_{27},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{28})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{32})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,)}(G_{35},t)}$ *are third detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{13})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1)}(G,t)}$

are fourth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{16})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2)}(G_{19},t)}$

are fifth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{20})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3)}(G_{23},t)}$

are sixth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{36})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7)}(G_{39},t)}$

are seventh detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{40})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8)}(G_{43},t)}$

are eighth detrition coefficients for category 1, 2 *and* 3

$\boxed{-(b''_{46})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1 2 3

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[\begin{matrix} (a'_{28})^{(5)}\boxed{+(a''_{28})^{(5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)} \end{matrix}\right] G_{28} \quad 79$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)} G_{28} - \begin{bmatrix} (a'_{29})^{(5)} \boxed{+(a''_{29})^{(5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{29}$$ 80

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)} G_{29} - \begin{bmatrix} (a'_{30})^{(5)} \boxed{+(a''_{30})^{(5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,)}(T_{25},t)} \boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{30}$$ 81

Where $\boxed{+(a''_{28})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5)}(T_{29},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3

And $\boxed{+(a''_{24})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,)}(T_{25},t)}$ *are second augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{32})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6)}(T_{33},t)}$ *are third augmentation coefficient for category* 1, 2 *and* 3

$\boxed{+(a''_{13})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{36})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7)}(T_{37},t)}$ are seventh augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8)}(T_{41},t)}$ are eighth augmentation coefficients for category 1,2, 3

$\boxed{+(a''_{46})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficients for category 1,2, 3

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)} T_{29} - \begin{bmatrix} (b'_{28})^{(5)} \boxed{-(b''_{28})^{(5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{28}$$ 82

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)} T_{28} - \begin{bmatrix} (b'_{29})^{(5)} \boxed{-(b''_{29})^{(5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{29}$$ 83

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)} T_{29} - \begin{bmatrix} (b'_{30})^{(5)} \boxed{-(b''_{30})^{(5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,)}(G_{27},t)} \boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{30}$$ 84

where $\boxed{-(b''_{28})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5)}(G_{31},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3

$\boxed{-(b''_{24})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,)}(G_{27},t)}$ *are second detrition coefficients*

for category 1,2 *and* 3 $\boxed{-(b''_{32})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6)}(G_{35},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,)}(G,t)}$ are fourth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1,2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1,2, and 3	
$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[\begin{matrix} (a'_{32})^{(6)} \boxed{+(a''_{32})^{(6)}(T_{33},t)} \boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{32}$	85
$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[\begin{matrix} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{33}$	86
$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[\begin{matrix} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)} \end{matrix} \right] G_{34}$	87
$\boxed{+(a''_{32})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coefficients for category* 1, 2 *and* 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients $\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients $\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients	

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7)}(T_{37},t)}$ seventh augmentation coefficients $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8)}(T_{41},t)}$ Eighth augmentation coefficients $\boxed{+(a''_{44})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9,9,9,9,9,9)}(T_{45},t)}$ ninth augmentation coefficients	
$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[\begin{matrix} (b'_{32})^{(6)}\boxed{-(b''_{32})^{(6)}(G_{35},t)}\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{32}$	88
$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[\begin{matrix} (b'_{33})^{(6)}\boxed{-(b''_{33})^{(6)}(G_{35},t)}\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{33}$	89
$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[\begin{matrix} (b'_{34})^{(6)}\boxed{-(b''_{34})^{(6)}(G_{35},t)}\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)} \end{matrix}\right] T_{34}$	90
$\boxed{-(b''_{32})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)}$ *are second detrition coefficients for category* 1, 2 *and* 3 $\boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)}$ *are third detrition coefficients for category* 1,2 *and* 3 $\boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)}$ are fourth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)}$ are fifth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)}$ are sixth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2, and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2, and 3	

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \begin{bmatrix} (a'_{36})^{(7)} \boxed{+(a''_{36})^{(7)}(T_{37},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$$ 91

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \begin{bmatrix} (a'_{37})^{(7)} \boxed{+(a''_{37})^{(7)}(T_{37},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$$ 92

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \begin{bmatrix} (a'_{38})^{(7)} \boxed{+(a''_{38})^{(7)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$$ 93

Where $\boxed{(a''_{36})^{(7)}(T_{37},t)}$, $\boxed{(a''_{37})^{(7)}(T_{37},t)}$, $\boxed{(a''_{38})^{(7)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,)}(T_{41},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \begin{bmatrix} (b'_{36})^{(7)} \boxed{-(b''_{36})^{(7)}(G_{39},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$$ 94

$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \begin{bmatrix} (b'_{37})^{(7)} \boxed{-(b''_{37})^{(7)}(G_{39},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{14}$	
$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \begin{bmatrix} (b'_{38})^{(7)} \boxed{-(b''_{38})^{(7)}(G_{39},t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)} \boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{15}$	
Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8)}(G_{43},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{44})^{(9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \begin{bmatrix} (a'_{40})^{(8)} \boxed{+(a''_{40})^{(8)}(T_{41},t)} \boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{13}$	*95*

$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \begin{bmatrix} (a'_{41})^{(8)} \boxed{+(a''_{41})^{(8)}(T_{41},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{14}$	
$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \begin{bmatrix} (a'_{42})^{(8)} \boxed{+(a''_{42})^{(8)}(T_{41},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)} \end{bmatrix} G_{15}$	
Where $\boxed{+(a''_{40})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8)}(T_{41},t)}$ are first augmentation coefficients for category 1, 2 and 3 $\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3 $\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are seventh augmentation coefficient for 1,2,3 $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$, $\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3 $\boxed{+(a''_{46})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$, $\boxed{+(a''_{44})^{(9,9,9,9,9,9,9,9,9)}(T_{45},t)}$ are ninth augmentation coefficient for 1,2,3	
$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \begin{bmatrix} (b'_{40})^{(8)} \boxed{-(b''_{40})^{(8)}(G_{43},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)} \end{bmatrix} T_{13}$	
$\frac{dT_{41}}{dt} =$	

$$(b_{41})^{(8)}T_{40}-\begin{bmatrix}(b'_{41})^{(8)}\boxed{-(b''_{41})^{(8)}(G_{43},t)}\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{14}$$

$$\frac{dT_{42}}{dt}=$$

$$(b_{42})^{(8)}T_{41}-\begin{bmatrix}(b'_{42})^{(8)}\boxed{-(b''_{42})^{(8)}(G_{43},t)}\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}\\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}\\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}\end{bmatrix}T_{15}$$

Where $\boxed{-(b''_{36})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7)}(G_{39},t)}$ are first detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{32})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are sixth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{38})^{(7,7,)}(G_{39},t)}$ are seventh detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3

$\boxed{-(b''_{44})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9,9,9,9,9,9,9,9,9)}(G_{47},t)}$ are ninth detrition coefficients for category 1, 2 and 3

$$\frac{dG_{44}}{dt}=(a_{44})^{(9)}G_{45}-\begin{bmatrix}(a'_{44})^{(9)}\boxed{+(a''_{44})^{(9)}(T_{45},t)}\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}\end{bmatrix}G_{13} \quad 96$$

$$\frac{dG_{45}}{dt}=(a_{45})^{(9)}G_{44}-\begin{bmatrix}(a'_{45})^{(9)}\boxed{+(a''_{45})^{(9)}(T_{45},t)}\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2,2)}(T_{17},t)}\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4,4)}(T_{25},t)}\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5,5)}(T_{29},t)}\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6,6)}(T_{33},t)}\\ \boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1,1)}(T_{14},t)}\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7,7)}(T_{37},t)}\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8,8)}(T_{41},t)}\end{bmatrix}G_{14}$$

$$\frac{dG_{46}}{dt} = (a_{46})^{(9)}G_{45} - \begin{bmatrix} (a'_{46})^{(9)} \boxed{+(a''_{46})^{(9)}(T_{37},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)} \boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)} \boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)} \end{bmatrix} G_{15}$$

Where $\boxed{+(a''_{44})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{45})^{(9)}(T_{45},t)}$, $\boxed{+(a''_{46})^{(9)}(T_{37},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a''_{16})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{17})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a''_{18})^{(2,2,2,2,2,2,2,2,2)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{20})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{21})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a''_{22})^{(3,3,3,3,3,3,3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{24})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{25})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a''_{26})^{(4,4,4,4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{28})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{29})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a''_{30})^{(5,5,5,5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{32})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{33})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a''_{34})^{(6,6,6,6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{13})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{14})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a''_{15})^{(1,1,1,1,1,1,1,1,1)}(T_{14},t)}$ are Seventh augmentation coefficient for category 1, 2 and 3

$\boxed{+(a''_{38})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{37})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ $\boxed{+(a''_{36})^{(7,7,7,7,7,7,7,7,7)}(T_{37},t)}$ are eighth augmentation coefficient for 1,2,3

$\boxed{+(a''_{40})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{42})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$, $\boxed{+(a''_{41})^{(8,8,8,8,8,8,8,8,8)}(T_{41},t)}$ are ninth augmentation coefficient for 1,2,3

$$\frac{dT_{44}}{dt} = (b_{44})^{(9)}T_{45} - \begin{bmatrix} (b'_{44})^{(9)} \boxed{-(b''_{44})^{(9)}(G_{47},t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{13}$$

$$\frac{dT_{45}}{dt} = (b_{45})^{(9)}T_{44} - \begin{bmatrix} (b'_{45})^{(9)} \boxed{-(b''_{45})^{(9)}(G_{47},t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} \boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} \boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} \boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{14}$$

$$\frac{dT_{46}}{dt} =$$

$(b_{46})^{(9)}T_{45} - \begin{bmatrix} (b'_{46})^{(9)} \boxed{-(b''_{46})^{(9)}(G_{47},t)} & \boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)} & \boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)} & \boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)} & \boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)} & \boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)} & \boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)} \end{bmatrix} T_{15}$	
Where $\boxed{-(b''_{44})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{45})^{(9)}(G_{47},t)}$, $\boxed{-(b''_{46})^{(9)}(G_{47},t)}$ are first detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{16})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{17})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$, $\boxed{-(b''_{18})^{(2,2,2,2,2,2,2,2,2)}(G_{19},t)}$ are second detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{20})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{21})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$, $\boxed{-(b''_{22})^{(3,3,3,3,3,3,3,3,3)}(G_{23},t)}$ are third detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{24})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{25})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$, $\boxed{-(b''_{26})^{(4,4,4,4,4,4,4,4,4)}(G_{27},t)}$ are fourth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{28})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{29})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$, $\boxed{-(b''_{30})^{(5,5,5,5,5,5,5,5,5)}(G_{31},t)}$ are fifth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{32})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{33})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$, $\boxed{-(b''_{34})^{(6,6,6,6,6,6,6,6,6)}(G_{35},t)}$ are sixth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{15})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{14})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$, $\boxed{-(b''_{13})^{(1,1,1,1,1,1,1,1,1)}(G,t)}$ are seventh detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{37})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{36})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$, $\boxed{-(b''_{38})^{(7,7,7,7,7,7,7,7,7)}(G_{39},t)}$ are eighth detrition coefficients for category 1, 2 and 3 $\boxed{-(b''_{42})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{41})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$, $\boxed{-(b''_{40})^{(8,8,8,8,8,8,8,8,8)}(G_{43},t)}$ are ninth detrition coefficients for category 1, 2 and 3	
Where we suppose	
$(a_i)^{(1)}, (a'_i)^{(1)}, (a''_i)^{(1)}, (b_i)^{(1)}, (b'_i)^{(1)}, (b''_i)^{(1)} > 0, \quad i,j = 13,14,15$ The functions $(a''_i)^{(1)}, (b''_i)^{(1)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(1)}, \ (r_i)^{(1)}$: $(a''_i)^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$ $(b''_i)^{(1)}(G,t) \leq \ (r_i)^{(1)} \leq (b'_i)^{(1)} \leq (\hat{B}_{13})^{(1)}$	*97*
$lim_{T_2 \to \infty} (a''_i)^{(1)} (T_{14},t) = (p_i)^{(1)}$ $\lim_{G \to \infty} (b''_i)^{(1)} (G,t) = \ (r_i)^{(1)}$ **Definition of** $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$: Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, \ (r_i)^{(1)}}$ are positive constants and $\boxed{i = 13,14,15}$	98
They satisfy Lipschitz condition:	99

$\lvert(a_i'')^{(1)}(T_{14}',t)-(a_i'')^{(1)}(T_{14},t)\rvert \leq (\hat{k}_{13})^{(1)}\lvert T_{14}-T_{14}'\rvert e^{-(\hat{M}_{13})^{(1)}t}$ $\lvert(b_i'')^{(1)}(G',t)-(b_i'')^{(1)}(G,t)\rvert < (\hat{k}_{13})^{(1)}\lvert\lvert G-G'\rvert\rvert e^{-(\hat{M}_{13})^{(1)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(1)}(T_{14}',t)$ and $(a_i'')^{(1)}(T_{14},t)$. (T_{14}',t) and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i'')^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)}=1$ then the function $(a_i'')^{(1)}(T_{14},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$: $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\ ,\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$	100
Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$: There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together With $(\hat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)}$ and $(\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i')^{(1)},(b_i)^{(1)},(b_i')^{(1)},(p_i)^{(1)},\ (r_i)^{(1)}, i=13,14,15,$ satisfy the inequalities $\frac{1}{(\hat{M}_{13})^{(1)}}[\ (a_i)^{(1)}+(a_i')^{(1)}+\ (\hat{A}_{13})^{(1)}+(\hat{P}_{13})^{(1)}\ (\hat{k}_{13})^{(1)}]<1$ $\frac{1}{(\hat{M}_{13})^{(1)}}[\ (b_i)^{(1)}+(b_i')^{(1)}+\ (\hat{B}_{13})^{(1)}+(\hat{Q}_{13})^{(1)}\ (\hat{k}_{13})^{(1)}]<1$	101
Where we suppose	
$(a_i)^{(2)},(a_i')^{(2)},(a_i'')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(b_i'')^{(2)}>0,\quad i,j=16,17,18$	
The functions $(a_i'')^{(2)},(b_i'')^{(2)}$ are positive continuous increasing and bounded.	
Definition of $(p_i)^{(2)},\ (r_i)^{(2)}$:	
$(a_i'')^{(2)}(T_{17},t)\leq(p_i)^{(2)}\leq\left(\hat{A}_{16}\right)^{(2)}$	102
$(b_i'')^{(2)}(G_{19},t)\leq\ (r_i)^{(2)}\leq(b_i')^{(2)}\leq(\hat{B}_{16})^{(2)}$	103
$\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t)=(p_i)^{(2)}$	104
$\lim_{G\to\infty}(b_i'')^{(2)}\left((G_{19}),t\right)=\ (r_i)^{(2)}$	105
Definition of $(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)}$: Where $\boxed{(\hat{A}_{16})^{(2)},(\hat{B}_{16})^{(2)},(p_i)^{(2)},\ (r_i)^{(2)}}$ are positive constants and $\boxed{i=16,17,18}$	106
They satisfy Lipschitz condition:	

$\lvert (a_i'')^{(2)}(T_{17}',t)-(a_i'')^{(2)}(T_{17},t)\rvert \leq (\hat{k}_{16})^{(2)}\lvert T_{17}-T_{17}'\rvert e^{-(\hat{M}_{16})^{(2)}t}$	107
$\lvert (b_i'')^{(2)}((G_{19})',t)-(b_i'')^{(2)}((G_{19}),t)\rvert < (\hat{k}_{16})^{(2)}\lvert\lvert (G_{19})-(G_{19})'\rvert\rvert e^{-(\hat{M}_{16})^{(2)}t}$	108
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) and (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)},(\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)}=1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$:	
$(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)}$, are positive constants $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\ ,\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}<1$	109
Definition of $(\hat{P}_{13})^{(2)},(\hat{Q}_{13})^{(2)}$: There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)},(\hat{k}_{16})^{(2)},(\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)},(a_i')^{(2)},(b_i)^{(2)},(b_i')^{(2)},(p_i)^{(2)},\ (r_i)^{(2)},i=16,17,18,$ satisfy the inequalities	
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (a_i)^{(2)}+(a_i')^{(2)}+\ (\hat{A}_{16})^{(2)}+\ (\hat{P}_{16})^{(2)}\ (\hat{k}_{16})^{(2)}]<1$	110
$\frac{1}{(\hat{M}_{16})^{(2)}}[\ (b_i)^{(2)}+(b_i')^{(2)}+\ (\hat{B}_{16})^{(2)}+\ (\hat{Q}_{16})^{(2)}\ \ (\hat{k}_{16})^{(2)}]<1$	111
Where we suppose	
$(a_i)^{(3)},(a_i')^{(3)},(a_i'')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(b_i'')^{(3)}>0,\quad i,j=20,21,22$ The functions $(a_i'')^{(3)},(b_i'')^{(3)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(3)},\ \ (\mathrm{r}_i)^{(3)}$: $(a_i'')^{(3)}(T_{21},t)\leq (p_i)^{(3)}\leq (\hat{A}_{20})^{(3)}$ $(b_i'')^{(3)}(G_{23},t)\leq\ \ (r_i)^{(3)}\leq (b_i')^{(3)}\leq (\hat{B}_{20})^{(3)}$	112
$lim_{T_2\to\infty}(a_i'')^{(3)}\ (T_{21},t)=(p_i)^{(3)}$ $\lim_{G\to\infty}(b_i'')^{(3)}\ (G_{23},t)=\ \ (r_i)^{(3)}$ **Definition of** $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)}$: Where $(\hat{A}_{20})^{(3)},(\hat{B}_{20})^{(3)},(p_i)^{(3)},\ \ (r_i)^{(3)}$ are positive constants and $i=20,21,22$	113

They satisfy Lipschitz condition: $\|(a_i'')^{(3)}(T_{21}',t) - (a_i'')^{(3)}(T_{21},t)\| \leq (\hat{k}_{20})^{(3)}\|T_{21} - T_{21}'\|e^{-(\hat{M}_{20})^{(3)}t}$ $\|(b_i'')^{(3)}(G_{23}',t) - (b_i'')^{(3)}(G_{23},t)\| < (\hat{k}_{20})^{(3)}\|\|G_{23} - G_{23}'\|\|e^{-(\hat{M}_{20})^{(3)}t}$	114
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and$(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $[(\hat{k}_{20})^{(3)},(\hat{M}_{20})^{(3)}]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the first augmentation coefficient attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$: $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)}$, are positive constants $\frac{(a_i)^{(3)}}{(\hat{M}_{20})^{(3)}}$, $\frac{(b_i)^{(3)}}{(\hat{M}_{20})^{(3)}} < 1$	115
There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\hat{M}_{20})^{(3)},(\hat{k}_{20})^{(3)},(\hat{A}_{20})^{(3)} and\ (\hat{B}_{20})^{(3)}$ and the constants $(a_i)^{(3)},(a_i')^{(3)},(b_i)^{(3)},(b_i')^{(3)},(p_i)^{(3)},\ (r_i)^{(3)}, i = 20,21,22,$ satisfy the inequalities $\frac{1}{(\hat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$ $\frac{1}{(\hat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1$	116
Where we suppose	
$(a_i)^{(4)},(a_i')^{(4)},(a_i'')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(b_i'')^{(4)} > 0, \quad i,j = 24,25,26$ The functions $(a_i'')^{(4)},(b_i'')^{(4)}$ are positive continuous increasing and bounded. **Definition of** $(p_i)^{(4)},\ (r_i)^{(4)}$: $(a_i'')^{(4)}(T_{25},t) \leq (p_i)^{(4)} \leq (\hat{A}_{24})^{(4)}$ $(b_i'')^{(4)}((G_{27}),t) \leq (r_i)^{(4)} \leq (b_i')^{(4)} \leq (\hat{B}_{24})^{(4)}$	117
$lim_{T_2\to\infty}(a_i'')^{(4)}(T_{25},t) = (p_i)^{(4)}$ $\lim_{G\to\infty}(b_i'')^{(4)}((G_{27}),t) = (r_i)^{(4)}$ **Definition of** $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)}$: Where $(\hat{A}_{24})^{(4)},(\hat{B}_{24})^{(4)},(p_i)^{(4)},\ (r_i)^{(4)}$ are positive constants and $i = 24,25,26$	118
They satisfy Lipschitz condition:	119

$\lvert(a_i'')^{(4)}(T_{25}',t)-(a_i'')^{(4)}(T_{25},t)\rvert \le (\hat{k}_{24})^{(4)}\lvert T_{25}-T_{25}'\rvert e^{-(\hat{M}_{24})^{(4)}t}$ $\lvert(b_i'')^{(4)}((G_{27})',t)-(b_i'')^{(4)}((G_{27}),t)\rvert < (\hat{k}_{24})^{(4)}\lvert\lvert(G_{27})-(G_{27})'\rvert\rvert e^{-(\hat{M}_{24})^{(4)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(4)}(T_{25}',t)$ and $(a_i'')^{(4)}(T_{25},t)$. (T_{25}',t) and (T_{25},t) are points belonging to the interval $[(\hat{k}_{24})^{(4)},(\hat{M}_{24})^{(4)}]$. It is to be noted that $(a_i'')^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)}=1$ then the function $(a_i'')^{(4)}(T_{25},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$: $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)}$, are positive constants $\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}$, $\frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}}<1$	120
<u>Definition of</u> $(\hat{P}_{24})^{(4)},(\hat{Q}_{24})^{(4)}$: There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with $(\hat{M}_{24})^{(4)},(\hat{k}_{24})^{(4)},(\hat{A}_{24})^{(4)} and (\hat{B}_{24})^{(4)}$ and the constants $(a_i)^{(4)},(a_i')^{(4)},(b_i)^{(4)},(b_i')^{(4)},(p_i)^{(4)},(r_i)^{(4)},i=24,25,26$, satisfy the inequalities $\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)}+(a_i')^{(4)}+(\hat{A}_{24})^{(4)}+(\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}]<1$ $\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)}+(b_i')^{(4)}+(\hat{B}_{24})^{(4)}+(\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}]<1$	121
Where we suppose	
$(a_i)^{(5)},(a_i')^{(5)},(a_i'')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(b_i'')^{(5)}>0,\quad i,j=28,29,30$ The functions $(a_i'')^{(5)},(b_i'')^{(5)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(5)},(r_i)^{(5)}$: $(a_i'')^{(5)}(T_{29},t)\le(p_i)^{(5)}\le(\hat{A}_{28})^{(5)}$ $(b_i'')^{(5)}((G_{31}),t)\le (r_i)^{(5)}\le(b_i')^{(5)}\le(\hat{B}_{28})^{(5)}$	122
$lim_{T_2\to\infty}(a_i'')^{(5)}(T_{29},t)=(p_i)^{(5)}$ $\lim_{G\to\infty}(b_i'')^{(5)}(G_{31},t)=(r_i)^{(5)}$ **<u>Definition of</u>** $(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)}$: Where $\boxed{(\hat{A}_{28})^{(5)},(\hat{B}_{28})^{(5)},(p_i)^{(5)},(r_i)^{(5)}}$ are positive constants and $\boxed{i=28,29,30}$	123

They satisfy Lipschitz condition: $\|(a_i'')^{(5)}(T_{29}',t)-(a_i'')^{(5)}(T_{29},t)\| \leq (\hat{k}_{28})^{(5)}\|T_{29}-T_{29}'\|e^{-(\hat{M}_{28})^{(5)}t}$ $\|(b_i'')^{(5)}((G_{31})',t)-(b_i'')^{(5)}\big((G_{31}),t\big)\| < (\hat{k}_{28})^{(5)}\|\|(G_{31})-(G_{31})'\|\|e^{-(\hat{M}_{28})^{(5)}t}$	124
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(5)}(T_{29}',t)$ and$(a_i'')^{(5)}(T_{29},t)$. (T_{29}',t) and (T_{29},t) are points belonging to the interval $\left[(\hat{k}_{28})^{(5)},(\hat{M}_{28})^{(5)}\right]$. It is to be noted that $(a_i'')^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)}=1$ then the function $(a_i'')^{(5)}(T_{29},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>**Definition of**</u> $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$: $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)}$, are positive constants $\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}\ ,\frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}}<1$	125
<u>**Definition of**</u> $(\hat{P}_{28})^{(5)},(\hat{Q}_{28})^{(5)}$: There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with $(\hat{M}_{28})^{(5)},(\hat{k}_{28})^{(5)},(\hat{A}_{28})^{(5)} and (\hat{B}_{28})^{(5)}$ and the constants $(a_i)^{(5)},(a_i')^{(5)},(b_i)^{(5)},(b_i')^{(5)},(p_i)^{(5)},\ (r_i)^{(5)},i=28,29,30,$ satisfy the inequalities $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (a_i)^{(5)}+(a_i')^{(5)}+\ (\hat{A}_{28})^{(5)}+\ (\hat{P}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}]<1$ $\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)}+(b_i')^{(5)}+\ (\hat{B}_{28})^{(5)}+\ (\hat{Q}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}]<1$	126
Where we suppose	
$(a_i)^{(6)},(a_i')^{(6)},(a_i'')^{(6)},(b_i)^{(6)},(b_i')^{(6)},(b_i'')^{(6)}>0,\quad i,j=32,33,34$ The functions $(a_i'')^{(6)},(b_i'')^{(6)}$ are positive continuous increasing and bounded. <u>**Definition of**</u> $(p_i)^{(6)},\ (r_i)^{(6)}$: $(a_i'')^{(6)}(T_{33},t)\leq(p_i)^{(6)}\leq(\hat{A}_{32})^{(6)}$ $(b_i'')^{(6)}((G_{35}),t)\leq\ (r_i)^{(6)}\leq(b_i')^{(6)}\leq(\hat{B}_{32})^{(6)}$	127
$lim_{T_2\to\infty}(a_i'')^{(6)}(T_{33},t)=(p_i)^{(6)}$ $\lim_{G\to\infty}(b_i'')^{(6)}\big((G_{35}),t\big)=\ (r_i)^{(6)}$ <u>**Definition of**</u> $(\hat{A}_{32})^{(6)},(\hat{B}_{32})^{(6)}$:	128

Where $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}$ are positive constants and $i = 32,33,34$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(6)}(T_{33}',t) - (a_i'')^{(6)}(T_{33},t)\rvert \leq (\hat{k}_{32})^{(6)}\lvert T_{33} - T_{33}'\rvert e^{-(\hat{M}_{32})^{(6)}t}$ $\lvert(b_i'')^{(6)}((G_{35})',t) - (b_i'')^{(6)}((G_{35}),t)\rvert < (\hat{k}_{32})^{(6)}\lvert\lvert(G_{35}) - (G_{35})'\rvert\rvert e^{-(\hat{M}_{32})^{(6)}t}$	
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(6)}(T_{33}',t)$ and $(a_i'')^{(6)}(T_{33},t)$. (T_{33}',t) and (T_{33},t) are points belonging to the interval $[(\hat{k}_{32})^{(6)}, (\hat{M}_{32})^{(6)}]$. It is to be noted that $(a_i'')^{(6)}(T_{33},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{32})^{(6)} = 1$ then the function $(a_i'')^{(6)}(T_{33},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants $\frac{(a_i)^{(6)}}{(\hat{M}_{32})^{(6)}} , \frac{(b_i)^{(6)}}{(\hat{M}_{32})^{(6)}} < 1$	129
<u>Definition of</u> $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\hat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and\ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (a_i)^{(6)} + (a_i')^{(6)} + \ (\hat{A}_{32})^{(6)} + \ (\hat{P}_{32})^{(6)}\ (\hat{k}_{32})^{(6)}] < 1$ $\frac{1}{(\hat{M}_{32})^{(6)}}[\ (b_i)^{(6)} + (b_i')^{(6)} + \ (\hat{B}_{32})^{(6)} + \ (\hat{Q}_{32})^{(6)}\ \ (\hat{k}_{32})^{(6)}] < 1$	130
Where we suppose	
(OOOOOOOOO) $(a_i)^{(7)}, (a_i')^{(7)}, (a_i'')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i'')^{(7)} > 0, \quad i,j = 36,37,38$ (PPPPPPPPP) The functions $(a_i'')^{(7)}, (b_i'')^{(7)}$ are positive continuous increasing and bounded. **<u>Definition of</u>** $(p_i)^{(7)}, \ (r_i)^{(7)}$: $(a_i'')^{(7)}(T_{37},t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$ $(b_i'')^{(7)}(G_{39},t) \leq \ (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$	131
(QQQQQQQQQ) $\lim_{T_2\to\infty} (a_i'')^{(7)}(T_{37},t) = (p_i)^{(7)}$ *(RRRRRRRRR)* $\lim_{G\to\infty}(b_i'')^{(7)}((G_{39}),t) = \ (r_i)^{(7)}$	132

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$: Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)},\ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$	
They satisfy Lipschitz condition: $\lvert(a_i'')^{(7)}(T_{37}',t) - (a_i'')^{(7)}(T_{37},t)\rvert \le (\hat{k}_{36})^{(7)}\lvert T_{37} - T_{37}'\rvert e^{-(\hat{M}_{36})^{(7)}t}$ $\lvert(b_i'')^{(7)}((G_{39})',t) - (b_i'')^{(7)}((G_{39}),t)\rvert < (\hat{k}_{36})^{(7)}\lvert\lvert(G_{39}) - (G_{39})'\rvert\rvert e^{-(\hat{M}_{36})^{(7)}t}$	133
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(7)}(T_{37}',t)$ and$(a_i'')^{(7)}(T_{37},t)$. (T_{37}',t) and (T_{37},t) are points belonging to the interval $\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a_i'')^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 1$ then the function $(a_i'')^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: (SSSSSSSSS) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\ ,\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$	134
Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: (TTTTTTTTT) There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and\ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i')^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (p_i)^{(7)},\ (r_i)^{(7)}, i = 36,37,38$, satisfy the inequalities $\frac{1}{(\hat{M}_{36})^{(7)}}[\,(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)}\,(\hat{k}_{36})^{(7)}] < 1$ $\frac{1}{(\hat{M}_{36})^{(7)}}[\,(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}\,(\hat{k}_{36})^{(7)}] < 1$	135
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$(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0, \quad i,j = 40,41,42$	136
The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded	
Definition of $(p_i)^{(8)},\ (r_i)^{(8)}$:	137
$(a_i'')^{(8)}(T_{41},t) \le (p_i)^{(8)} \le (\hat{A}_{40})^{(8)}$	138

$(b_i'')^{(8)}((G_{43}),t) \leq \ (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$	139
$\lim_{T_2\to\infty} (a_i'')^{(8)}(T_{41},t) = (p_i)^{(8)}$	140
$\lim_{G\to\infty} (b_i'')^{(8)}\left((G_{43}),t\right) = \ (r_i)^{(8)}$	141
<u>Definition of</u> $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$: Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}}$ are positive constants and $\boxed{i = 40,41,42}$	
They satisfy Lipschitz condition:	
$\lvert(a_i'')^{(8)}(T_{41}',t) - (a_i'')^{(8)}(T_{41},t)\rvert \leq (\hat{k}_{40})^{(8)}\lvert T_{41} - T_{41}'\rvert e^{-(\hat{M}_{40})^{(8)}t}$	142
$\lvert(b_i'')^{(8)}((G_{43})',t) - (b_i'')^{(8)}\left((G_{43}),t\right)\rvert < (\hat{k}_{40})^{(8)}\lvert\lvert(G_{43}) - (G_{43})'\rvert\rvert e^{-(\hat{M}_{40})^{(8)}t}$	143
With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(8)}(T_{41}',t)$ and $(a_i'')^{(8)}(T_{41},t)$. (T_{41}',t) and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)}, (\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i'')^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)} = 1$ then the function $(a_i'')^{(8)}(T_{41},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.	
<u>Definition of</u> $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$:	
$(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}$, are positive constants	
$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}} \ , \frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$	144
<u>Definition of</u> $(\hat{P}_{40})^{(8)}, (\hat{Q}_{40})^{(8)}$: There exists two constants $(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ which together with $(\hat{M}_{40})^{(8)}, (\hat{k}_{40})^{(8)}, (\hat{A}_{40})^{(8)}$ $(\hat{B}_{40})^{(8)}$ and the constants $(a_i)^{(8)}, (a_i')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (p_i)^{(8)}, \ (r_i)^{(8)}, i = 40,41,42,$ Satisfy the inequalities	
$\frac{1}{(\hat{M}_{40})^{(8)}}[\,(a_i)^{(8)} + (a_i')^{(8)} + \ (\hat{A}_{40})^{(8)} + (\hat{P}_{40})^{(8)}\,(\hat{k}_{40})^{(8)}] < 1$	145
$\frac{1}{(\hat{M}_{40})^{(8)}}[\ (b_i)^{(8)} + (b_i')^{(8)} + \ (\hat{B}_{40})^{(8)} + (\hat{Q}_{40})^{(8)}\ (\hat{k}_{40})^{(8)}] < 1$	146
Where we suppose	
$(a_i)^{(9)}, (a_i')^{(9)}, (a_i'')^{(9)}, (b_i)^{(9)}, (b_i')^{(9)}, (b_i'')^{(9)} > 0, \quad i,j = 44,45,46$	146 A

The functions $(a_i^{''})^{(9)}, (b_i^{''})^{(9)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(9)}, \ (r_i)^{(9)}$:

$(a_i^{''})^{(9)}(T_{45},t) \leq (p_i)^{(9)} \leq (\hat{A}_{44})^{(9)}$

$(b_i^{''})^{(9)}(G_{47},t) \leq \ (r_i)^{(9)} \leq (b_i^{'})^{(9)} \leq (\hat{B}_{44})^{(9)}$

$\lim_{T_2\to\infty} (a_i^{''})^{(9)} (T_{45},t) = (p_i)^{(9)}$

$\lim_{G\to\infty} (b_i^{''})^{(9)} (G_{47},t) = \ (r_i)^{(9)}$

Definition of $(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}$:

Where $\boxed{(\hat{A}_{44})^{(9)}, (\hat{B}_{44})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}}$ are positive constants and $\boxed{i = 44,45,46}$

They satisfy Lipschitz condition:

$|(a_i^{''})^{(9)}(T_{45}^{'},t) - (a_i^{''})^{(9)}(T_{45},t)| \leq (\hat{k}_{44})^{(9)}|T_{45} - T_{45}^{'}|e^{-(\hat{M}_{44})^{(9)}t}$

$|(b_i^{''})^{(9)}((G_{47})^{'},t) - (b_i^{''})^{(9)}\big((G_{47}),t\big)| < (\hat{k}_{44})^{(9)}||(G_{47}) - (G_{47})^{'}||e^{-(\hat{M}_{44})^{(9)}t}$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(9)}(T_{45}^{'},t)$ and$(a_i^{''})^{(9)}(T_{45},t)$. $(T_{45}^{'},t)$ and (T_{45},t) are points belonging to the interval $\big[(\hat{k}_{44})^{(9)}, (\hat{M}_{44})^{(9)}\big]$. It is to be noted that $(a_i^{''})^{(9)}(T_{45},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{44})^{(9)} = 1$ then the function $(a_i^{''})^{(9)}(T_{45},t)$, the **first augmentation coefficient** attributable to the system, would be absolutely continuous.

Definition of $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$:

$(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}$, are positive constants

$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}} \ , \frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}} < 1$

Definition of $(\hat{P}_{44})^{(9)}, (\hat{Q}_{44})^{(9)}$:

There exists two constants $(\hat{P}_{44})^{(9)}$ and $(\hat{Q}_{44})^{(9)}$ which together with $(\hat{M}_{44})^{(9)}, (\hat{k}_{44})^{(9)}, (\hat{A}_{44})^{(9)} and \ (\hat{B}_{44})^{(9)}$ and the constants $(a_i)^{(9)}, (a_i^{'})^{(9)}, (b_i)^{(9)}, (b_i^{'})^{(9)}, (p_i)^{(9)}, \ (r_i)^{(9)}, i = 44,45,46,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\,(a_i)^{(9)} + (a_i^{'})^{(9)} + \ (\hat{A}_{44})^{(9)} + \ (\hat{P}_{44})^{(9)}\ (\hat{k}_{44})^{(9)}] < 1$$

$$\frac{1}{(\hat{M}_{44})^{(9)}}[\ (b_i)^{(9)} + (b_i^{'})^{(9)} + \ (\hat{B}_{44})^{(9)} + \ (\hat{Q}_{44})^{(9)}\ \ (\hat{k}_{44})^{(9)}] < 1$$

Theorem 1: if the conditions above are fulfilled, there exists a solution satisfying the conditions Definition of $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	147
Theorem 2 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$ $G_i(t) \leq (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t}$, $T_i(0) = T_i^0 > 0$	148
Theorem 3 : if the conditions above are fulfilled, there exists a solution satisfying the conditions $G_i(t) \leq (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $G_i(0) = G_i^0 > 0$ $T_i(t) \leq (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t}$, $T_i(0) = T_i^0 > 0$	149
Theorem 4 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	150
Theorem 5 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	151
Theorem 6 : if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	152
Theorem 7: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$:	153

$G_i(t) \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	
Theorem 8: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 A
Theorem 9: if the conditions above are fulfilled, there exists a solution satisfying the conditions **Definition of** $G_i(0), T_i(0)$: $G_i(t) \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$ $T_i(t) \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$	153 B
Proof: Consider operator $\mathcal{A}^{(1)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	154
$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq (\hat{P}_{13})^{(1)}$, $T_i^0 \leq (\hat{Q}_{13})^{(1)}$,	155
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	156
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} t}$	157
By $\bar{G}_{13}(t) = G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} G_{14}(s_{(13)}) - \left((a_{13}^{'})^{(1)} + a_{13}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{13}(s_{(13)})\right] ds_{(13)}$	158
$\bar{G}_{14}(t) = G_{14}^0 + \int_0^t \left[(a_{14})^{(1)} G_{13}(s_{(13)}) - \left((a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{G}_{15}(t) = G_{15}^0 + \int_0^t \left[(a_{15})^{(1)} G_{14}(s_{(13)}) - \left((a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}(s_{(13)}), s_{(13)})\right) G_{15}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{13}(t) = T_{13}^0 + \int_0^t \left[(b_{13})^{(1)} T_{14}(s_{(13)}) - \left((b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{13}(s_{(13)})\right] ds_{(13)}$	
$\bar{T}_{14}(t) = T_{14}^0 + \int_0^t \left[(b_{14})^{(1)} T_{13}(s_{(13)}) - \left((b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{14}(s_{(13)})\right] ds_{(13)}$	
$\bar{\mathrm{T}}_{15}(\mathrm{t}) = \mathrm{T}_{15}^0 + \int_0^t \left[(b_{15})^{(1)} T_{14}(s_{(13)}) - \left((b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G(s_{(13)}), s_{(13)})\right) T_{15}(s_{(13)})\right] ds_{(13)}$	

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	159
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \leq (\,\hat{P}_{16}\,)^{(2)}\,, T_i^0 \leq (\,\hat{Q}_{16}\,)^{(2)},$	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{16}\,)^{(2)} e^{(\,\hat{M}_{16}\,)^{(2)} t}$	
By $\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}')^{(2)} + a_{16}'')^{(2)}\left(T_{17}(s_{(16)}), s_{(16)}\right)\right) G_{16}(s_{(16)})\right] ds_{(16)}$	160
$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}')^{(2)} + (a_{17}'')^{(2)}\left(T_{17}(s_{(16)}), s_{(17)}\right)\right) G_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}')^{(2)} + (a_{18}'')^{(2)}\left(T_{17}(s_{(16)}), s_{(16)}\right)\right) G_{18}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}')^{(2)} - (b_{16}'')^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{16}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}')^{(2)} - (b_{17}'')^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{17}(s_{(16)})\right] ds_{(16)}$	
$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}')^{(2)} - (b_{18}'')^{(2)}\left(G_{19}(s_{(16)}), s_{(16)}\right)\right) T_{18}(s_{(16)})\right] ds_{(16)}$ Where $s_{(16)}$ is the integrand that is integrated over an interval $(0,t)$	
Proof: Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions $G_i\,,\,T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0\,,\, T_i(0) = T_i^0\,,\, G_i^0 \leq (\,\hat{P}_{20}\,)^{(3)}\,, T_i^0 \leq (\,\hat{Q}_{20}\,)^{(3)},$	
$0 \leq G_i(t) - G_i^0 \leq (\,\hat{P}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\,\hat{Q}_{20}\,)^{(3)} e^{(\,\hat{M}_{20}\,)^{(3)} t}$	
By $\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)}\left(T_{21}(s_{(20)}), s_{(20)}\right)\right) G_{20}(s_{(20)})\right] ds_{(20)}$	161
$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)}\left(T_{21}(s_{(20)}), s_{(20)}\right)\right) G_{21}(s_{(20)})\right] ds_{(20)}$	

$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)}$	
$\bar{T}_{22}(t) = T_{22}^0 + \int_0^t \left[(b_{22})^{(3)} T_{21}(s_{(20)}) - \left((b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}(s_{(20)}), s_{(20)})\right) T_{22}(s_{(20)})\right] ds_{(20)}$ Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{24})^{(4)}, T_i^0 \leq (\hat{Q}_{24})^{(4)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t}$	
By $\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}(s_{(24)}) - \left((a_{24}^{'})^{(4)} + a_{24}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{24}(s_{(24)})\right] ds_{(24)}$	162
$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}(s_{(24)}) - \left((a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}(s_{(24)}) - \left((a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}(s_{(24)}), s_{(24)})\right) G_{26}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}(s_{(24)}) - \left((b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{24}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}(s_{(24)}) - \left((b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{25}(s_{(24)})\right] ds_{(24)}$	
$\bar{T}_{26}(t) = T_{26}^0 + \int_0^t \left[(b_{26})^{(4)} T_{25}(s_{(24)}) - \left((b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}(G_{27}(s_{(24)}), s_{(24)})\right) T_{26}(s_{(24)})\right] ds_{(24)}$ Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{28})^{(5)}, T_i^0 \leq (\hat{Q}_{28})^{(5)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t}$	
By	163

$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}(s_{(28)}) - \left((a_{28}')^{(5)} + a_{28}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}(s_{(28)}) - \left((a_{29}')^{(5)} + (a_{29}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}(s_{(28)}) - \left((a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\right) G_{30}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}(s_{(28)}) - \left((b_{28}')^{(5)} - (b_{28}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{28}(s_{(28)})\right] ds_{(28)}$	
$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}(s_{(28)}) - \left((b_{29}')^{(5)} - (b_{29}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{29}(s_{(28)})\right] ds_{(28)}$	
$\bar{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^0 + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}')^{(5)} - (b_{30}'')^{(5)}(G_{31}(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)}$ Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{32})^{(6)}, T_i^0 \leq (\hat{Q}_{32})^{(6)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t}$	
By $\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$	164
$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)}$	
$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}')^{(6)} - (b_{33}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)}$	
$\bar{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^0 + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}')^{(6)} - (b_{34}'')^{(6)}(G_{35}(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)}$ Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	

$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\hat{P}_{36})^{(7)} \,, T_i^0 \leq (\hat{Q}_{36})^{(7)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t}$	
By $\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)}$	165
$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$	
$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)}$	
$\bar{\mathrm{T}}_{38}(\mathrm{t}) = \mathrm{T}_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39}(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)}$ Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i\,, T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	
$G_i(0) = G_i^0 \,,\, T_i(0) = T_i^0 \,,\, G_i^0 \leq (\hat{P}_{40})^{(8)} \,, T_i^0 \leq (\hat{Q}_{40})^{(8)},$	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} t}$	
By $\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}(s_{(40)}) - \left((a'_{40})^{(8)} + a''_{40})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{40}(s_{(40)})\right] ds_{(40)}$	166
$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}(s_{(40)}) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41}(s_{(40)}), s_{(40)})\right) G_{41}(s_{(40)})\right] ds_{(40)}$	

$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}(s_{(40)}) - \left((a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)}) \right) G_{42}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}(s_{(40)}) - \left((b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{40}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{41}(t) = T_{41}^0 + \int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b_{41}^{'})^{(8)} - (b_{41}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{41}(s_{(40)}) \right] ds_{(40)}$	
$\bar{T}_{42}(t) = T_{42}^0 + \int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)} (G_{43}(s_{(40)}), s_{(40)}) \right) T_{42}(s_{(40)}) \right] ds_{(40)}$ Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$	
Proof: Consider operator $\mathcal{A}^{(9)}$ defined on the space of sextuples of continuous functions $G_i, T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy	166 A
$G_i(0) = G_i^0, T_i(0) = T_i^0, G_i^0 \leq (\hat{P}_{44})^{(9)}, T_i^0 \leq (\hat{Q}_{44})^{(9)}$,	
$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{44})^{(9)} e^{(\hat{M}_{44})^{(9)} t}$	
By $\bar{G}_{44}(t) = G_{44}^0 + \int_0^t \left[(a_{44})^{(9)} G_{45}(s_{(44)}) - \left((a_{44}^{'})^{(9)} + a_{44}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{45}(t) = G_{45}^0 + \int_0^t \left[(a_{45})^{(9)} G_{44}(s_{(44)}) - \left((a_{45}^{'})^{(9)} + (a_{45}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{G}_{46}(t) = G_{46}^0 + \int_0^t \left[(a_{46})^{(9)} G_{45}(s_{(44)}) - \left((a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)} (T_{45}(s_{(44)}), s_{(44)}) \right) G_{46}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{44}(t) = T_{44}^0 + \int_0^t \left[(b_{44})^{(9)} T_{45}(s_{(44)}) - \left((b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{44}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{45}(t) = T_{45}^0 + \int_0^t \left[(b_{45})^{(9)} T_{44}(s_{(44)}) - \left((b_{45}^{'})^{(9)} - (b_{45}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{45}(s_{(44)}) \right] ds_{(44)}$	
$\bar{T}_{46}(t) = T_{46}^0 + \int_0^t \left[(b_{46})^{(9)} T_{45}(s_{(44)}) - \left((b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)} (G_{47}(s_{(44)}), s_{(44)}) \right) T_{46}(s_{(44)}) \right] ds_{(44)}$ Where $s_{(44)}$ is the integrand that is integrated over an interval $(0, t)$	
The operator $\mathcal{A}^{(1)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{13}(t) \leq G_{13}^0 + \int_0^t \left[(a_{13})^{(1)} \left(G_{14}^0 + (\hat{P}_{13})^{(1)} e^{(\hat{M}_{13})^{(1)} s_{(13)}} \right) \right] ds_{(13)} =$ $\left(1 + (a_{13})^{(1)} t\right) G_{14}^0 + \frac{(a_{13})^{(1)} (\hat{P}_{13})^{(1)}}{(\hat{M}_{13})^{(1)}} \left(e^{(\hat{M}_{13})^{(1)} t} - 1 \right)$	167
From which it follows that	168

$(G_{13}(t) - G_{13}^0)e^{-(\hat{M}_{13})^{(1)}t} \leq \frac{(a_{13})^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{P}_{13})^{(1)} + G_{14}^0\right)e^{\left(-\frac{(\hat{P}_{13})^{(1)}+G_{14}^0}{G_{14}^0}\right)} + (\hat{P}_{13})^{(1)}\right]$ (G_i^0) is as defined in the statement of theorem 1	
Analogous inequalities hold also for $G_{14}, G_{15}, T_{13}, T_{14}, T_{15}$	
The operator $\mathcal{A}^{(2)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{16}(t) \leq G_{16}^0 + \int_0^t \left[(a_{16})^{(2)}\left(G_{17}^0 + (\hat{P}_{16})^{(6)}e^{(\hat{M}_{16})^{(2)}s_{(16)}}\right)\right] ds_{(16)} =$ $\left(1 + (a_{16})^{(2)}t\right)G_{17}^0 + \frac{(a_{16})^{(2)}(\hat{P}_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left(e^{(\hat{M}_{16})^{(2)}t} - 1\right)$	169
From which it follows that $(G_{16}(t) - G_{16}^0)e^{-(\hat{M}_{16})^{(2)}t} \leq \frac{(a_{16})^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{P}_{16})^{(2)} + G_{17}^0\right)e^{\left(-\frac{(\hat{P}_{16})^{(2)}+G_{17}^0}{G_{17}^0}\right)} + (\hat{P}_{16})^{(2)}\right]$	170
Analogous inequalities hold also for $G_{17}, G_{18}, T_{16}, T_{17}, T_{18}$	
The operator $\mathcal{A}^{(3)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{20}(t) \leq G_{20}^0 + \int_0^t \left[(a_{20})^{(3)}\left(G_{21}^0 + (\hat{P}_{20})^{(3)}e^{(\hat{M}_{20})^{(3)}s_{(20)}}\right)\right] ds_{(20)} =$ $\left(1 + (a_{20})^{(3)}t\right)G_{21}^0 + \frac{(a_{20})^{(3)}(\hat{P}_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left(e^{(\hat{M}_{20})^{(3)}t} - 1\right)$	171
From which it follows that $(G_{20}(t) - G_{20}^0)e^{-(\hat{M}_{20})^{(3)}t} \leq \frac{(a_{20})^{(3)}}{(\hat{M}_{20})^{(3)}}\left[\left((\hat{P}_{20})^{(3)} + G_{21}^0\right)e^{\left(-\frac{(\hat{P}_{20})^{(3)}+G_{21}^0}{G_{21}^0}\right)} + (\hat{P}_{20})^{(3)}\right]$	172
Analogous inequalities hold also for $G_{21}, G_{22}, T_{20}, T_{21}, T_{22}$	
The operator $\mathcal{A}^{(4)}$ maps the space of functions satisfying into itself .Indeed it is obvious that $G_{24}(t) \leq G_{24}^0 + \int_0^t \left[(a_{24})^{(4)}\left(G_{25}^0 + (\hat{P}_{24})^{(4)}e^{(\hat{M}_{24})^{(4)}s_{(24)}}\right)\right] ds_{(24)} =$ $\left(1 + (a_{24})^{(4)}t\right)G_{25}^0 + \frac{(a_{24})^{(4)}(\hat{P}_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left(e^{(\hat{M}_{24})^{(4)}t} - 1\right)$	173
From which it follows that $(G_{24}(t) - G_{24}^0)e^{-(\hat{M}_{24})^{(4)}t} \leq \frac{(a_{24})^{(4)}}{(\hat{M}_{24})^{(4)}}\left[\left((\hat{P}_{24})^{(4)} + G_{25}^0\right)e^{\left(-\frac{(\hat{P}_{24})^{(4)}+G_{25}^0}{G_{25}^0}\right)} + (\hat{P}_{24})^{(4)}\right]$ (G_i^0) is as defined in the statement of theorem 4	174
The operator $\mathcal{A}^{(5)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious	

that $G_{28}(t) \leq G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} \left(G_{29}^0 + (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} s_{(28)}}\right)\right] ds_{(28)} =$ $\left(1 + (a_{28})^{(5)} t\right) G_{29}^0 + \frac{(a_{28})^{(5)} (\hat{P}_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left(e^{(\hat{M}_{28})^{(5)} t} - 1\right)$	
From which it follows that $(G_{28}(t) - G_{28}^0) e^{-(\hat{M}_{28})^{(5)} t} \leq \frac{(a_{28})^{(5)}}{(\hat{M}_{28})^{(5)}} \left[\left((\hat{P}_{28})^{(5)} + G_{29}^0\right) e^{\left(-\frac{(\hat{P}_{28})^{(5)} + G_{29}^0}{G_{29}^0}\right)} + (\hat{P}_{28})^{(5)}\right]$ (G_i^0) is as defined in the statement of theorem 5	175
The operator $\mathcal{A}^{(6)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{32}(t) \leq G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} \left(G_{33}^0 + (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} s_{(32)}}\right)\right] ds_{(32)} =$ $\left(1 + (a_{32})^{(6)} t\right) G_{33}^0 + \frac{(a_{32})^{(6)} (\hat{P}_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left(e^{(\hat{M}_{32})^{(6)} t} - 1\right)$	176
From which it follows that $(G_{32}(t) - G_{32}^0) e^{-(\hat{M}_{32})^{(6)} t} \leq \frac{(a_{32})^{(6)}}{(\hat{M}_{32})^{(6)}} \left[\left((\hat{P}_{32})^{(6)} + G_{33}^0\right) e^{\left(-\frac{(\hat{P}_{32})^{(6)} + G_{33}^0}{G_{33}^0}\right)} + (\hat{P}_{32})^{(6)}\right]$ (G_i^0) is as defined in the statement of theorem 6 Analogous inequalities hold also for G_{25} , G_{26}, T_{24}, T_{25}, T_{26}	177
(ll) The operator $\mathcal{A}^{(7)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that $G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} \left(G_{37}^0 + (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} s_{(36)}}\right)\right] ds_{(36)} =$ $\left(1 + (a_{36})^{(7)} t\right) G_{37}^0 + \frac{(a_{36})^{(7)} (\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left(e^{(\hat{M}_{36})^{(7)} t} - 1\right)$	178
From which it follows that $(G_{36}(t) - G_{36}^0) e^{-(\hat{M}_{36})^{(7)} t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left[\left((\hat{P}_{36})^{(7)} + G_{37}^0\right) e^{\left(-\frac{(\hat{P}_{36})^{(7)} + G_{37}^0}{G_{37}^0}\right)} + (\hat{P}_{36})^{(7)}\right]$ (G_i^0) is as defined in the statement of theorem 7	
The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying Equations into itself .Indeed it is obvious that	
$G_{40}(t) \leq G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}}\right)\right] ds_{(40)} =$	180

$\left(1+(a_{40})^{(8)}t\right)G_{41}^0+\frac{(a_{40})^{(8)}(\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left(e^{(\hat{M}_{40})^{(8)}t}-1\right)$	
From which it follows that $(G_{40}(t)-G_{40}^0)e^{-(\hat{M}_{40})^{(8)}t}\leq\frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{P}_{40})^{(8)}+G_{41}^0\right)e^{\left(-\frac{(\hat{P}_{40})^{(8)}+G_{41}^0}{G_{41}^0}\right)}+(\hat{P}_{40})^{(8)}\right]$ (G_i^0) is as defined in the statement of theorem 8 Analogous inequalities hold also for G_{41} , G_{42}, T_{40}, T_{41}, T_{42}	181
The operator $\mathcal{A}^{(9)}$ maps the space of functions satisfying 34,35,36 into itself .Indeed it is obvious that $G_{44}(t)\leq G_{44}^0+\int_0^t\left[(a_{44})^{(9)}\left(G_{45}^0+(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\right)\right]ds_{(44)}=$ $\left(1+(a_{44})^{(9)}t\right)G_{45}^0+\frac{(a_{44})^{(9)}(\hat{P}_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left(e^{(\hat{M}_{44})^{(9)}t}-1\right)$	
From which it follows that $(G_{44}(t)-G_{44}^0)e^{-(\hat{M}_{44})^{(9)}t}\leq\frac{(a_{44})^{(9)}}{(\hat{M}_{44})^{(9)}}\left[\left((\hat{P}_{44})^{(9)}+G_{45}^0\right)e^{\left(-\frac{(\hat{P}_{44})^{(9)}+G_{45}^0}{G_{45}^0}\right)}+(\hat{P}_{44})^{(9)}\right]$ (G_i^0) is as defined in the statement of theorem 9 Analogous inequalities hold also for G_{45} , G_{46}, T_{44}, T_{45}, T_{46}	
It is now sufficient to take $\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}<1$ and to choose $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ large to have	182
$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[(\hat{P}_{13})^{(1)}+\left((\hat{P}_{13})^{(1)}+G_j^0\right)e^{-\left(\frac{(\hat{P}_{13})^{(1)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{13})^{(1)}$	183
$\frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}}\left[\left((\hat{Q}_{13})^{(1)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{13})^{(1)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{13})^{(1)}\right]\leq(\hat{Q}_{13})^{(1)}$	184
In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i , T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric $d\left(\left(G^{(1)},T^{(1)}\right),\left(G^{(2)},T^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\left\|G_i^{(1)}(t)-G_i^{(2)}(t)\right\|e^{-(\hat{M}_{13})^{(1)}t},\max_{t\in\mathbb{R}_+}\left\|T_i^{(1)}(t)-T_i^{(2)}(t)\right\|e^{-(\hat{M}_{13})^{(1)}t}\}$	185

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In the same way , one can obtain $G_{26} \leq \left((\widehat{M}_{24})^{(4)} \right)_3 = G_{26}^0 + 2(a_{26})^{(4)} \left((\widehat{M}_{24})^{(4)} \right)_2 / (a_{26}^{'})^{(4)}$ If G_{25} *or* G_{26} is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.	
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Then $\frac{dT_{25}}{dt} \geq (a_{25})^{(4)}(m)^{(4)} - \varepsilon_4 T_{25}$ which leads to $T_{25} \geq \left(\frac{(a_{25})^{(4)}(m)^{(4)}}{\varepsilon_4} \right)(1 - e^{-\varepsilon_4 t}) + T_{25}^0 e^{-\varepsilon_4 t}$ If we take t such that $e^{-\varepsilon_4 t} = \frac{1}{2}$ it results $T_{25} \geq \left(\frac{(a_{25})^{(4)}(m)^{(4)}}{2} \right), \quad t = log \frac{2}{\varepsilon_4}$ By taking now ε_4 sufficiently small one sees that T_{25} is unbounded. The same property holds for T_{26} if $\lim_{t\to\infty} (b_{26}^{''})^{(4)} \left((G_{27})(t), t \right) = (b_{26}^{'})^{(4)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 42 Analogous inequalities hold also for G_{29} , G_{30}, T_{28}, T_{29}, T_{30}	232
It is now sufficient to take $\frac{(a_i)^{(5)}}{(\widehat{M}_{28})^{(5)}}$, $\frac{(b_i)^{(5)}}{(\widehat{M}_{28})^{(5)}} < 1$ and to choose $(\widehat{P}_{28})^{(5)}$ and $(\widehat{Q}_{28})^{(5)}$ large to have	233
$\frac{(a_i)^{(5)}}{(\widehat{M}_{28})^{(5)}} \left[(\widehat{P}_{28})^{(5)} + ((\widehat{P}_{28})^{(5)} + G_j^0) e^{-\left(\frac{(\widehat{P}_{28})^{(5)} + G_j^0}{G_j^0} \right)} \right] \leq (\widehat{P}_{28})^{(5)}$	234
$\frac{(b_i)^{(5)}}{(\widehat{M}_{28})^{(5)}} \left[((\widehat{Q}_{28})^{(5)} + T_j^0) e^{-\left(\frac{(\widehat{Q}_{28})^{(5)} + T_j^0}{T_j^0} \right)} + (\widehat{Q}_{28})^{(5)} \right] \leq (\widehat{Q}_{28})^{(5)}$	235
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$sup_i\{\max_{t\in\mathbb{R}_+} \left\|G_i^{(1)}(t) - G_i^{(2)}(t)\right\| e^{-(\widehat{M}_{28})^{(5)}t}, \max_{t\in\mathbb{R}_+} \left\|T_i^{(1)}(t) - T_i^{(2)}(t)\right\| e^{-(\widehat{M}_{28})^{(5)}t}\}$ Indeed if we denote **Definition of** $\widetilde{(G_{31})}, \widetilde{(T_{31})}$: $\left(\widetilde{(G_{31})}, \widetilde{(T_{31})}\right) = \mathcal{A}^{(5)}\left((G_{31}),(T_{31})\right)$ It results $\left\|\tilde{G}_{28}^{(1)} - \tilde{G}_i^{(2)}\right\| \leq \int_0^t (a_{28})^{(5)} \left\|G_{29}^{(1)} - G_{29}^{(2)}\right\| e^{-(\widehat{M}_{28})^{(5)}s_{(28)}} e^{(\widehat{M}_{28})^{(5)}s_{(28)}}\, ds_{(28)} +$ $\int_0^t \{(a_{28}^{'})^{(5)} \left\|G_{28}^{(1)} - G_{28}^{(2)}\right\| e^{-(\widehat{M}_{28})^{(5)}s_{(28)}} e^{-(\widehat{M}_{28})^{(5)}s_{(28)}} +$ $(a_{28}^{''})^{(5)}\left(T_{29}^{(1)}, s_{(28)}\right)\left\|G_{28}^{(1)} - G_{28}^{(2)}\right\| e^{-(\widehat{M}_{28})^{(5)}s_{(28)}} e^{(\widehat{M}_{28})^{(5)}s_{(28)}} +$ $G_{28}^{(2)}\left\|(a_{28}^{''})^{(5)}\left(T_{29}^{(1)}, s_{(28)}\right) - (a_{28}^{''})^{(5)}\left(T_{29}^{(2)}, s_{(28)}\right)\right\|\ e^{-(\widehat{M}_{28})^{(5)}s_{(28)}} e^{(\widehat{M}_{28})^{(5)}s_{(28)}}\} ds_{(28)}$ Where $s_{(28)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$ From the hypotheses on it follows	
$\left\|(G_{31})^{(1)} - (G_{31})^{(2)}\right\| e^{-(\widehat{M}_{28})^{(5)}t} \leq$ $\frac{1}{(\widehat{M}_{28})^{(5)}}\left((a_{28})^{(5)} + (a_{28}^{'})^{(5)} + (\widehat{A}_{28})^{(5)} + (\widehat{P}_{28})^{(5)}(\widehat{k}_{28})^{(5)}\right) d\left(\left((G_{31})^{(1)}, (T_{31})^{(1)};\ (G_{31})^{(2)}, (T_{31})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	237
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$G_{28} < (\widehat{M}_{28})^{(5)}$ it follows $\frac{dG_{29}}{dt} \leq \left((\widehat{M}_{28})^{(5)}\right)_1 - (a_{29}')^{(5)} G_{29}$ and by integrating $G_{29} \leq \left((\widehat{M}_{28})^{(5)}\right)_2 = G_{29}^0 + 2(a_{29})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_1/(a_{29}')^{(5)}$ In the same way , one can obtain $G_{30} \leq \left((\widehat{M}_{28})^{(5)}\right)_3 = G_{30}^0 + 2(a_{30})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_2/(a_{30}')^{(5)}$ If G_{29} *or* G_{30} is bounded, the same property follows for G_{28} , G_{30} and G_{28} , G_{29} respectively.	
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$\frac{(a_i)^{(6)}}{(M_{32})^{(6)}}\left[(\widehat{P}_{32})^{(6)} + ((\widehat{P}_{32})^{(6)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{32})^{(6)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{32})^{(6)}$	245
$\frac{(b_i)^{(6)}}{(M_{32})^{(6)}}\left[((\widehat{Q}_{32})^{(6)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{32})^{(6)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{32})^{(6)}\right] \leq (\widehat{Q}_{32})^{(6)}$	246
In order that the operator $\mathcal{A}^{(6)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	

The operator $\mathcal{A}^{(6)}$ is a contraction with respect to the metric 247

$d\left(\left((G_{35})^{(1)},(T_{35})^{(1)}\right),\left((G_{35})^{(2)},(T_{35})^{(2)}\right)\right)=$

$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\widehat{M}_{32})^{(6)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\widehat{M}_{32})^{(6)}t}\}$

Indeed if we denote

Definition of $\widetilde{(G_{35})},\widetilde{(T_{35})}$: $\left(\widetilde{(G_{35})},\widetilde{(T_{35})}\right)=\mathcal{A}^{(6)}\left((G_{35}),(T_{35})\right)$

It results

$\left|\tilde{G}_{32}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{32})^{(6)}\left|G_{33}^{(1)}-G_{33}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\,ds_{(32)}+$

$\int_0^t\{(a'_{32})^{(6)}\left|G_{32}^{(1)}-G_{32}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}+$

$(a''_{32})^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)\left|G_{32}^{(1)}-G_{32}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}+$

$G_{32}^{(2)}|(a''_{32})^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)-(a''_{32})^{(6)}\left(T_{33}^{(2)},s_{(32)}\right)|\ e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$

Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses it follows

$\left|(G_{35})^{(1)}-(G_{35})^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}t}\leq$ 248
$\frac{1}{(\widehat{M}_{32})^{(6)}}\left((a_{32})^{(6)}+(a'_{32})^{(6)}+(\widehat{A}_{32})^{(6)}+(\widehat{P}_{32})^{(6)}(\widehat{k}_{32})^{(6)}\right)d\left(\left((G_{35})^{(1)},(T_{35})^{(1)};\ (G_{35})^{(2)},(T_{35})^{(2)}\right)\right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 26: The fact that we supposed $(a''_{32})^{(6)}$ and $(b''_{32})^{(6)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{32})^{(6)}e^{(\widehat{M}_{32})^{(6)}t}$ *and* $(\widehat{Q}_{32})^{(6)}e^{(\widehat{M}_{32})^{(6)}t}$ respectively of $\mathbb{R}_+$. 249

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(6)}$ and $(b''_i)^{(6)}, i=32,33,34$ depend only on T_{33} and respectively on (G_{35})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 27: There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$ 250

it results

$G_i(t)\geq G_i^0e^{\left[-\int_0^t\{(a'_i)^{(6)}-(a''_i)^{(6)}(T_{33}(s_{(32)}),s_{(32)})\}ds_{(32)}\right]}\geq 0$

$T_i(t)\geq T_i^0e^{\left(-(b'_i)^{(6)}t\right)}>0$ for $\mathrm{t}>0$

Definition of $\left((\widehat{M}_{32})^{(6)}\right)_1, \left((\widehat{M}_{32})^{(6)}\right)_2$ *and* $\left((\widehat{M}_{32})^{(6)}\right)_3$: **Remark 28:** if G_{32} is bounded, the same property have also G_{33} *and* G_{34} . indeed if $G_{32} < (\widehat{M}_{32})^{(6)}$ it follows $\frac{dG_{33}}{dt} \leq \left((\widehat{M}_{32})^{(6)}\right)_1 - (a'_{33})^{(6)} G_{33}$ and by integrating $G_{33} \leq \left((\widehat{M}_{32})^{(6)}\right)_2 = G_{33}^0 + 2(a_{33})^{(6)}\left((\widehat{M}_{32})^{(6)}\right)_1 / (a'_{33})^{(6)}$ In the same way , one can obtain $G_{34} \leq \left((\widehat{M}_{32})^{(6)}\right)_3 = G_{34}^0 + 2(a_{34})^{(6)}\left((\widehat{M}_{32})^{(6)}\right)_2 / (a'_{34})^{(6)}$ If G_{33} *or* G_{34} is bounded, the same property follows for G_{32} , G_{34} and G_{32} , G_{33} respectively.	251
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Then $\frac{dT_{33}}{dt} \geq (a_{33})^{(6)}(m)^{(6)} - \varepsilon_6 T_{33}$ which leads to $T_{33} \geq \left(\frac{(a_{33})^{(6)}(m)^{(6)}}{\varepsilon_6}\right)(1 - e^{-\varepsilon_6 t}) + T_{33}^0 e^{-\varepsilon_6 t}$ If we take t such that $e^{-\varepsilon_6 t} = \frac{1}{2}$ it results $T_{33} \geq \left(\frac{(a_{33})^{(6)}(m)^{(6)}}{2}\right), \quad t = log\frac{2}{\varepsilon_6}$ By taking now ε_6 sufficiently small one sees that T_{33} is unbounded. The same property holds for T_{34} if $\lim_{t\to\infty}(b''_{34})^{(6)}\left((G_{35})(t), t(t), t\right) = (b'_{34})^{(6)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	254
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$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[(\widehat{P}_{36})^{(7)} + ((\widehat{P}_{36})^{(7)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{36})^{(7)} + G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{36})^{(7)}$	256
$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[((\widehat{Q}_{36})^{(7)} + T_j^0)e^{-\left(\frac{(\widehat{Q}_{36})^{(7)} + T_j^0}{T_j^0}\right)} + (\widehat{Q}_{36})^{(7)}\right] \leq (\widehat{Q}_{36})^{(7)}$	257

In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself

The operator $\mathcal{A}^{(7)}$ is a contraction with respect to the metric 258

$d\left(\left((G_{39})^{(1)},(T_{39})^{(1)}\right),\left((G_{39})^{(2)},(T_{39})^{(2)}\right)\right)=$

$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\widehat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\widehat{M}_{36})^{(7)}t}\}$

Indeed if we denote

Definition of $\widetilde{(G_{39})},\widetilde{(T_{39})}$: $\left(\widetilde{(G_{39})},\widetilde{(T_{39})}\right)=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$

It results

$\left|\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{36})^{(7)}\left|G_{37}^{(1)}-G_{37}^{(2)}\right|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\,ds_{(36)}+$
$\int_0^t\{(a'_{36})^{(7)}\left|G_{36}^{(1)}-G_{36}^{(2)}\right|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}+$
$(a''_{36})^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)\left|G_{36}^{(1)}-G_{36}^{(2)}\right|e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}+$
$G_{36}^{(2)}|(a''_{36})^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)-(a''_{36})^{(7)}\left(T_{37}^{(2)},s_{(36)}\right)|\;e^{-(\widehat{M}_{36})^{(7)}s_{(36)}}e^{(\widehat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$

Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses on it follows

$\left|(G_{39})^{(1)}-(G_{39})^{(2)}\right|e^{-(\widehat{M}_{36})^{(7)}t}\leq$ 259
$\frac{1}{(\widehat{M}_{36})^{(7)}}\left((a_{36})^{(7)}+(a'_{36})^{(7)}+(\widehat{A}_{36})^{(7)}+(\widehat{P}_{36})^{(7)}(\widehat{k}_{36})^{(7)}\right)d\left(\left((G_{39})^{(1)},(T_{39})^{(1)};\;(G_{39})^{(2)},(T_{39})^{(2)}\right)\right)$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows

Remark 31: The fact that we supposed $(a''_{36})^{(7)}$ and $(b''_{36})^{(7)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{36})^{(7)}e^{(\widehat{M}_{36})^{(7)}t}$ *and* $(\widehat{Q}_{36})^{(7)}e^{(\widehat{M}_{36})^{(7)}t}$ respectively of $\mathbb{R}_+$. 260

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(7)}$ and $(b''_i)^{(7)}, i=36,37,38$ depend only on T_{37} and respectively on (G_{39}) (*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 32: There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$ 261

it results

$G_i(t)\geq G_i^0 e^{\left[-\int_0^t\{(a'_i)^{(7)}-(a''_i)^{(7)}(T_{37}(s_{(36)}),s_{(36)})\}ds_{(36)}\right]}\geq 0$

$T_i\,(t) \geq T_i^0 e^{\left(-(b_i')^{(7)}t\right)} > 0$ for t > 0	
Definition of $\left((\widehat{M}_{36})^{(7)}\right)_1, \left((\widehat{M}_{36})^{(7)}\right)_2$ *and* $\left((\widehat{M}_{36})^{(7)}\right)_3$: **Remark 33:** if G_{36} is bounded, the same property have also G_{37} *and* G_{38} . indeed if $G_{36} < (\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt} \leq \left((\widehat{M}_{36})^{(7)}\right)_1 - (a_{37}')^{(7)} G_{37}$ and by integrating $G_{37} \leq \left((\widehat{M}_{36})^{(7)}\right)_2 = G_{37}^0 + 2(a_{37})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_1/(a_{37}')^{(7)}$ In the same way , one can obtain $G_{38} \leq \left((\widehat{M}_{36})^{(7)}\right)_3 = G_{38}^0 + 2(a_{38})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_2/(a_{38}')^{(7)}$ If G_{37} *or* G_{38} is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.	262
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Remark 35: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(7)}((G_{39})(t),t)) = (b_{37}')^{(7)}$ then $T_{37} \to \infty$. **Definition of** $(m)^{(7)}$ and ε_7 : Indeed let t_7 be so that for $t > t_7$ $(b_{37})^{(7)} - (b_i'')^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}\,(t) > (m)^{(7)}$	264
Then $\frac{dT_{37}}{dt} \geq (a_{37})^{(7)}(m)^{(7)} - \varepsilon_7 T_{37}$ which leads to $T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{\varepsilon_7}\right)(1-e^{-\varepsilon_7 t}) + T_{37}^0 e^{-\varepsilon_7 t}$ If we take t such that $e^{-\varepsilon_7 t} = \frac{1}{2}$ it results $T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_7}$ By taking now ε_7 sufficiently small one sees that T_{37} is unbounded. The same property holds for T_{38} if $\lim_{t\to\infty}(b_{38}'')^{(7)}\left((G_{39})(t),t\right) = (b_{38}')^{(7)}$ We now state a more precise theorem about the behaviors at infinity of the solutions of equations	265
It is now sufficient to take $\frac{(a_i)^{(8)}}{(\widehat{M}_{40})^{(8)}}, \frac{(b_i)^{(8)}}{(\widehat{M}_{40})^{(8)}} < 1$ and to choose $(\widehat{P}_{40})^{(8)}$ and $(\widehat{Q}_{40})^{(8)}$ large to have	266
$\frac{(a_i)^{(8)}}{(\widehat{M}_{40})^{(8)}}\left[(\widehat{P}_{40})^{(8)} + ((\widehat{P}_{40})^{(8)} + G_j^0)e^{-\left(\frac{(\widehat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{40})^{(8)}$	267
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$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{40})^{(8)}\right]\leq(\hat{Q}_{40})^{(8)}$	
In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i, T_i satisfying Equations into itself	
The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric	
$d\left(\left((G_{43})^{(1)},(T_{43})^{(1)}\right),\left((G_{43})^{(2)},(T_{43})^{(2)}\right)\right)=$ $\sup_i\{\max_{t\in\mathbb{R}_+}\lvert G_i^{(1)}(t)-G_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t},\max_{t\in\mathbb{R}_+}\lvert T_i^{(1)}(t)-T_i^{(2)}(t)\rvert e^{-(\hat{M}_{40})^{(8)}t}\}$	269
Indeed if we denote **Definition of** $\widetilde{(G_{43})},\widetilde{(T_{43})}$: $\left(\widetilde{(G_{43})},\widetilde{(T_{43})}\right)=\mathcal{A}^{(8)}((G_{43}),(T_{43}))$	270
It results $\lvert\tilde{G}_{40}^{(1)}-\tilde{G}_i^{(2)}\rvert\leq\int_0^t(a_{40})^{(8)}\lvert G_{41}^{(1)}-G_{41}^{(2)}\rvert e^{-(\widehat{M}_{40})^{(8)}s_{(40)}}e^{(\widehat{M}_{40})^{(8)}s_{(40)}}ds_{(40)}+$ $\int_0^t\{(a'_{40})^{(8)}\lvert G_{40}^{(1)}-G_{40}^{(2)}\rvert e^{-(\widehat{M}_{40})^{(8)}s_{(40)}}e^{-(\widehat{M}_{40})^{(8)}s_{(40)}}+$ $(a''_{40})^{(8)}(T_{41}^{(1)},s_{(40)})\lvert G_{40}^{(1)}-G_{40}^{(2)}\rvert e^{-(\widehat{M}_{40})^{(8)}s_{(40)}}e^{(\widehat{M}_{40})^{(8)}s_{(40)}}+$ $G_{40}^{(2)}\lvert(a''_{40})^{(8)}(T_{41}^{(1)},s_{(40)})-(a''_{40})^{(8)}(T_{41}^{(2)},s_{(40)})\rvert\ e^{-(\widehat{M}_{40})^{(8)}s_{(40)}}e^{(\widehat{M}_{40})^{(8)}s_{(40)}}\}ds_{(40)}$	271
Where $s_{(40)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ From the hypotheses it follows	272
$\lvert(G_{43})^{(1)}-(G_{43})^{(2)}\rvert e^{-(\widehat{M}_{40})^{(8)}t}\leq$ $\frac{1}{(\widehat{M}_{40})^{(8)}}\left((a_{40})^{(8)}+(a'_{40})^{(8)}+(\widehat{A}_{40})^{(8)}+(\widehat{P}_{40})^{(8)}(\widehat{k}_{40})^{(8)}\right)d\left(\left((G_{43})^{(1)},(T_{43})^{(1)};\ (G_{43})^{(2)},(T_{43})^{(2)}\right)\right)$ And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis the result follows	273
Remark 36: The fact that we supposed $(a''_{40})^{(8)}$ and $(b''_{40})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ *and* $(\widehat{Q}_{40})^{(8)}e^{(\widehat{M}_{40})^{(8)}t}$ respectively of $\mathbb{R}_+$. If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(8)}$ and $(b''_i)^{(8)}, i=40,41,42$ depend only on T_{41} and respectively on (G_{43})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.	274
Remark 37 There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$	275

it results $G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(8)} - (a_i'')^{(8)}(T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$ $T_i(t) \geq T_i^0 e^{(-(b_i')^{(8)} t)} > 0$ for $t > 0$	
Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2$ *and* $\left((\widehat{M}_{40})^{(8)}\right)_3$: **Remark 38:** if G_{40} is bounded, the same property have also G_{41} *and* G_{42} . indeed if $G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}')^{(8)} G_{41}$ and by integrating $G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1 / (a_{41}')^{(8)}$ In the same way , one can obtain $G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2 / (a_{42}')^{(8)}$ If G_{41} *or* G_{42} is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.	276
Remark 39: If G_{40} *is* bounded, from below, the same property holds for G_{41} *and* G_{42} . The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below.	277
Remark 40: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(8)}((G_{43})(t), t)) = (b_{41}')^{(8)}$ then $T_{41} \to \infty$. **Definition of** $(m)^{(8)}$ and ε_8 : Indeed let t_8 be so that for $t > t_8$ $(b_{41})^{(8)} - (b_i'')^{(8)}\left((G_{43})(t), t\right) < \varepsilon_8, T_{40}(t) > (m)^{(8)}$	278
Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1 - e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results $T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}'')^{(8)}\left((G_{43})(t), t(t), t\right) = (b_{42}')^{(8)}$	279
It is now sufficient to take $\frac{(a_i)^{(9)}}{(\widehat{M}_{44})^{(9)}}$, $\frac{(b_i)^{(9)}}{(\widehat{M}_{44})^{(9)}} < 1$ and to choose $(\widehat{P}_{44})^{(9)}$ and $(\widehat{Q}_{44})^{(9)}$ large to have	279 A

$$\frac{(a_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[(\hat{P}_{44})^{(9)}+((\hat{P}_{44})^{(9)}+G_j^0)e^{-\left(\frac{(\hat{P}_{44})^{(9)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{44})^{(9)}$$

$$\frac{(b_i)^{(9)}}{(\hat{M}_{44})^{(9)}}\left[((\hat{Q}_{44})^{(9)}+T_j^0)e^{-\left(\frac{(\hat{Q}_{44})^{(9)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{44})^{(9)}\right]\leq(\hat{Q}_{44})^{(9)}$$

In order that the operator $\mathcal{A}^{(9)}$ transforms the space of sextuples of functions G_i, T_i satisfying 39,35,36 into itself

The operator $\mathcal{A}^{(9)}$ is a contraction with respect to the metric

$$d\left(((G_{47})^{(1)},(T_{47})^{(1)}),((G_{47})^{(2)},(T_{47})^{(2)})\right)=$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\hat{M}_{44})^{(9)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{47})},\widetilde{(T_{47})}:(\widetilde{(G_{47})},\widetilde{(T_{47})})=\mathcal{A}^{(9)}((G_{47}),(T_{47}))$
It results

$$\left|\tilde{G}_{44}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{44})^{(9)}\left|G_{45}^{(1)}-G_{45}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\,ds_{(44)}+$$
$$\int_0^t\{(a'_{44})^{(9)}\left|G_{44}^{(1)}-G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{-(\hat{M}_{44})^{(9)}s_{(44)}}+$$
$$(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})\left|G_{44}^{(1)}-G_{44}^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}+$$
$$G_{44}^{(2)}|(a''_{44})^{(9)}(T_{45}^{(1)},s_{(44)})-(a''_{44})^{(9)}(T_{45}^{(2)},s_{(44)})|\;e^{-(\hat{M}_{44})^{(9)}s_{(44)}}e^{(\hat{M}_{44})^{(9)}s_{(44)}}\}ds_{(44)}$$

Where $s_{(44)}$ represents integrand that is integrated over the interval $[0,t]$

From the hypotheses on 45,46,47,28 and 29 it follows

$$\left|(G_{47})^{(1)}-G^{(2)}\right|e^{-(\hat{M}_{44})^{(9)}t}\leq$$
$$\frac{1}{(\hat{M}_{44})^{(9)}}\left((a_{44})^{(9)}+(a'_{44})^{(9)}+(\hat{A}_{44})^{(9)}+(\hat{P}_{44})^{(9)}(\hat{k}_{44})^{(9)}\right)d\left(((G_{47})^{(1)},(T_{47})^{(1)};\;(G_{47})^{(2)},(T_{47})^{(2)})\right)$$

And analogous inequalities for G_i *and* T_i. Taking into account the hypothesis (39,35,36) the result follows

Remark 41: The fact that we supposed $(a''_{44})^{(9)}$ and $(b''_{44})^{(9)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ *and* $(\hat{Q}_{44})^{(9)}e^{(\hat{M}_{44})^{(9)}t}$ respectively of $\mathbb{R}_+$.

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(9)}$ and $(b''_i)^{(9)}, i=44,45,46$ depend only on T_{45} and respectively on (G_{47})(*and not on* t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 42: There does not exist any t where $G_i(t)=0$ *and* $T_i(t)=0$

From 99 to 44 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(9)} - (a_i'')^{(9)}(T_{45}(s_{(44)}), s_{(44)})\} ds_{(44)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{(-(b_i')^{(9)} t)} > 0 \quad \text{for } t > 0$$

Definition of $\left((\widehat{M}_{44})^{(9)}\right)_1, \left((\widehat{M}_{44})^{(9)}\right)_2$ *and* $\left((\widehat{M}_{44})^{(9)}\right)_3$:

Remark 43: if G_{44} is bounded, the same property have also G_{45} *and* G_{46} . indeed if

$G_{44} < (\widehat{M}_{44})^{(9)}$ it follows $\frac{dG_{45}}{dt} \leq \left((\widehat{M}_{44})^{(9)}\right)_1 - (a_{45}')^{(9)} G_{45}$ and by integrating

$G_{45} \leq \left((\widehat{M}_{44})^{(9)}\right)_2 = G_{45}^0 + 2(a_{45})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_1 / (a_{45}')^{(9)}$

In the same way , one can obtain

$G_{46} \leq \left((\widehat{M}_{44})^{(9)}\right)_3 = G_{46}^0 + 2(a_{46})^{(9)}\left((\widehat{M}_{44})^{(9)}\right)_2 / (a_{46}')^{(9)}$

If G_{45} *or* G_{46} is bounded, the same property follows for G_{44} , G_{46} and G_{44} , G_{45} respectively.

Remark 44: If G_{44} *is* bounded, from below, the same property holds for G_{45} *and* G_{46} . The proof is analogous with the preceding one. An analogous property is true if G_{45} is bounded from below.

Remark 45: If T_{44} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(9)}((G_{47})(t), t)) = (b_{45}')^{(9)}$ then $T_{45} \to \infty$.

Definition of $(m)^{(9)}$ and ε_9 :

Indeed let t_9 be so that for $t > t_9$

$$(b_{45})^{(9)} - (b_i'')^{(9)}((G_{47})(t), t) < \varepsilon_9, T_{44}(t) > (m)^{(9)}$$

Then $\frac{dT_{45}}{dt} \geq (a_{45})^{(9)}(m)^{(9)} - \varepsilon_9 T_{45}$ which leads to

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{\varepsilon_9}\right)(1 - e^{-\varepsilon_9 t}) + T_{45}^0 e^{-\varepsilon_9 t}$ If we take t such that $e^{-\varepsilon_9 t} = \frac{1}{2}$ it results

$T_{45} \geq \left(\frac{(a_{45})^{(9)}(m)^{(9)}}{2}\right), \quad t = \log \frac{2}{\varepsilon_9}$ By taking now ε_9 sufficiently small one sees that T_{45} is unbounded.
The same property holds for T_{46} if $\lim_{t\to\infty}(b_{46}'')^{(9)}((G_{47})(t), t) = (b_{46}')^{(9)}$
We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 92

Behavior of the solutions of equation 280

Theorem If we denote and define

Definition of $(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$:

$(\sigma_1)^{(1)}, (\sigma_2)^{(1)}, (\tau_1)^{(1)}, (\tau_2)^{(1)}$ four constants satisfying
$-(\sigma_2)^{(1)} \leq -(a_{13}')^{(1)} + (a_{14}')^{(1)} - (a_{13}'')^{(1)}(T_{14}, t) + (a_{14}'')^{(1)}(T_{14}, t) \leq -(\sigma_1)^{(1)}$

$-(\tau_2)^{(1)} \leq -(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G,t) - (b_{14}^{''})^{(1)}(G,t) \leq -(\tau_1)^{(1)}$	
Definition of $(\nu_1)^{(1)}, (\nu_2)^{(1)}, (u_1)^{(1)}, (u_2)^{(1)}, \nu^{(1)}, u^{(1)}$: By $(\nu_1)^{(1)} > 0$, $(\nu_2)^{(1)} < 0$ and respectively $(u_1)^{(1)} > 0$, $(u_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_1)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	281
Definition of $(\bar{\nu}_1)^{(1)},, (\bar{\nu}_2)^{(1)}, (\bar{u}_1)^{(1)}, (\bar{u}_2)^{(1)}$: By $(\bar{\nu}_1)^{(1)} > 0$, $(\bar{\nu}_2)^{(1)} < 0$ and respectively $(\bar{u}_1)^{(1)} > 0$, $(\bar{u}_2)^{(1)} < 0$ the roots of the equations $(a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)} = 0$ and $(b_{14})^{(1)}\left(u^{(1)}\right)^2 + (\tau_2)^{(1)}u^{(1)} - (b_{13})^{(1)} = 0$	282
Definition of $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}, (\nu_0)^{(1)}$:- If we define $(m_1)^{(1)}, (m_2)^{(1)}, (\mu_1)^{(1)}, (\mu_2)^{(1)}$ by $(m_2)^{(1)} = (\nu_0)^{(1)}, (m_1)^{(1)} = (\nu_1)^{(1)},\ if\ (\nu_0)^{(1)} < (\nu_1)^{(1)}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\bar{\nu}_1)^{(1)},\ if\ (\nu_1)^{(1)} < (\nu_0)^{(1)} < (\bar{\nu}_1)^{(1)},$ and $\boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$ $(m_2)^{(1)} = (\nu_1)^{(1)}, (m_1)^{(1)} = (\nu_0)^{(1)},\ if\ (\bar{\nu}_1)^{(1)} < (\nu_0)^{(1)}$	283
and analogously $(\mu_2)^{(1)} = (u_0)^{(1)}, (\mu_1)^{(1)} = (u_1)^{(1)},\ if\ (u_0)^{(1)} < (u_1)^{(1)}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (\bar{u}_1)^{(1)},\ if\ (u_1)^{(1)} < (u_0)^{(1)} < (\bar{u}_1)^{(1)},$ and $\boxed{(u_0)^{(1)} = \frac{T_{13}^0}{T_{14}^0}}$ $(\mu_2)^{(1)} = (u_1)^{(1)}, (\mu_1)^{(1)} = (u_0)^{(1)}, if\ (\bar{u}_1)^{(1)} < (u_0)^{(1)}$ where $(u_1)^{(1)}, (\bar{u}_1)^{(1)}$ are defined	284
Then the solution of global equations satisfies the inequalities $G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{13}(t) \leq G_{13}^0 e^{(S_1)^{(1)}t}$ where $(p_i)^{(1)}$ is defined by equation $\frac{1}{(m_1)^{(1)}} G_{13}^0 e^{((S_1)^{(1)} - (p_{13})^{(1)})t} \leq G_{14}(t) \leq \frac{1}{(m_2)^{(1)}} G_{13}^0 e^{(S_1)^{(1)}t}$	285
$\left(\frac{(a_{15})^{(1)}G_{13}^0}{(m_1)^{(1)}((S_1)^{(1)} - (p_{13})^{(1)} - (S_2)^{(1)})}\left[e^{((S_1)^{(1)} - (p_{13})^{(1)})t} - e^{-(S_2)^{(1)}t}\right] + G_{15}^0 e^{-(S_2)^{(1)}t} \leq G_{15}(t) \leq\right.$ $\left.\frac{(a_{15})^{(1)}G_{13}^0}{(m_2)^{(1)}((S_1)^{(1)} - (a_{15}^{'})^{(1)})}\left[e^{(S_1)^{(1)}t} - e^{-(a_{15}^{'})^{(1)}t}\right] + G_{15}^0 e^{-(a_{15}^{'})^{(1)}t}\right)$	286

$T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	287
$\frac{1}{(\mu_1)^{(1)}} T_{13}^0 e^{(R_1)^{(1)}t} \leq T_{13}(t) \leq \frac{1}{(\mu_2)^{(1)}} T_{13}^0 e^{((R_1)^{(1)}+(r_{13})^{(1)})t}$	288
$\frac{(b_{15})^{(1)}T_{13}^0}{(\mu_1)^{(1)}((R_1)^{(1)}-(b_{15}')^{(1)})}\left[e^{(R_1)^{(1)}t}-e^{-(b_{15}')^{(1)}t}\right]+T_{15}^0 e^{-(b_{15}')^{(1)}t} \leq T_{15}(t) \leq$ $\frac{(a_{15})^{(1)}T_{13}^0}{(\mu_2)^{(1)}((R_1)^{(1)}+(r_{13})^{(1)}+(R_2)^{(1)})}\left[e^{((R_1)^{(1)}+(r_{13})^{(1)})t}-e^{-(R_2)^{(1)}t}\right]+T_{15}^0 e^{-(R_2)^{(1)}t}$	289
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Behavior of the solutions of equation **Theorem 2:** If we denote and define	291
Definition of $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$: $(\sigma_1)^{(2)}, (\sigma_2)^{(2)}, (\tau_1)^{(2)}, (\tau_2)^{(2)}$ four constants satisfying	292
$-(\sigma_2)^{(2)} \leq -(a_{16}')^{(2)} + (a_{17}')^{(2)} - (a_{16}'')^{(2)}(T_{17}, t) + (a_{17}'')^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)}$	293
$-(\tau_2)^{(2)} \leq -(b_{16}')^{(2)} + (b_{17}')^{(2)} - (b_{16}'')^{(2)}((G_{19}), t) - (b_{17}'')^{(2)}((G_{19}), t) \leq -(\tau_1)^{(2)}$	294
Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$:	295
By $(\nu_1)^{(2)} > 0, (\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0, (u_2)^{(2)} < 0$ the roots	296
of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	297
and $(b_{14})^{(2)}(u^{(2)})^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and	298
Definition of $(\bar{\nu}_1)^{(2)},, (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$:	299
By $(\bar{\nu}_1)^{(2)} > 0, (\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0, (\bar{u}_2)^{(2)} < 0$ the	300
roots of the equations $(a_{17})^{(2)}(\nu^{(2)})^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$	301
and $(b_{17})^{(2)}(u^{(2)})^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$	302
Definition of $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$:-	303

If we define $(m_1)^{(2)}, (m_2)^{(2)}, (\mu_1)^{(2)}, (\mu_2)^{(2)}$ by	304
$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}, \ \boldsymbol{if} \ (\nu_0)^{(2)} < (\nu_1)^{(2)}$	305
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}, \boldsymbol{if} \ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)},$ and $(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}$	306
$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}, \ \boldsymbol{if} \ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$	307
and analogously $(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}, \ \boldsymbol{if} \ (u_0)^{(2)} < (u_1)^{(2)}$ $(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}, \boldsymbol{if} \ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)},$ and $(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}$	308
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Then the solution of global equations satisfies the inequalities $G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)} t}$	310
$(p_i)^{(2)}$ is defined by equation	
$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{17}(t) \leq \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)} t}$	311
$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)} - (p_{16})^{(2)} - (S_2)^{(2)})} \left[e^{((S_1)^{(2)} - (p_{16})^{(2)})t} - e^{-(S_2)^{(2)} t} \right] + G_{18}^0 e^{-(S_2)^{(2)} t} \leq G_{18}(t) \leq \right.$ $\left. \frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)} - (a'_{18})^{(2)})} \left[e^{(S_1)^{(2)} t} - e^{-(a'_{18})^{(2)} t} \right] + G_{18}^0 e^{-(a'_{18})^{(2)} t} \right)$	312
$T_{16}^0 e^{(R_1)^{(2)} t} \leq T_{16}(t) \leq T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	313
$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)} t} \leq T_{16}(t) \leq \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)} + (r_{16})^{(2)})t}$	314
$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)} - (b'_{18})^{(2)})} \left[e^{(R_1)^{(2)} t} - e^{-(b'_{18})^{(2)} t} \right] + T_{18}^0 e^{-(b'_{18})^{(2)} t} \leq T_{18}(t) \leq$ $\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)} + (r_{16})^{(2)} + (R_2)^{(2)})} \left[e^{((R_1)^{(2)} + (r_{16})^{(2)})t} - e^{-(R_2)^{(2)} t} \right] + T_{18}^0 e^{-(R_2)^{(2)} t}$	315
Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:-	316
Where $(S_1)^{(2)} = (a_{16})^{(2)} (m_2)^{(2)} - (a'_{16})^{(2)}$	317

$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$	
$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}^{'})^{(2)}$ $(R_2)^{(2)} = (b_{18}^{'})^{(2)} - (r_{18})^{(2)}$	318
Behavior of the solutions **Theorem 3:** If we denote and define **Definition of** $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$: $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying $-(\sigma_2)^{(3)} \leq -(a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} - (a_{20}^{''})^{(3)}(T_{21}, t) + (a_{21}^{''})^{(3)}(T_{21}, t) \leq -(\sigma_1)^{(3)}$ $-(\tau_2)^{(3)} \leq -(b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}, t) - (b_{21}^{''})^{(3)}\left((G_{23}), t\right) \leq -(\tau_1)^{(3)}$	319
Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}\left(\nu^{(3)}\right)^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$ and $(b_{21})^{(3)}\left(u^{(3)}\right)^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$	320
Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by $(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)},\ \boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)},\ \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$, and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$ $(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$	321
and analogously $(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)},\ \boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$ $(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)},\ \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$	322

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}, \; \boldsymbol{if} \; (\bar{u}_1)^{(3)} < (u_0)^{(3)}$ Then the solution of global equations satisfies the inequalities $G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{20}(t) \leq G_{20}^0 e^{(S_1)^{(3)}t}$ $(p_i)^{(3)}$ is defined by equation	
$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)}-(p_{20})^{(3)})t} \leq G_{21}(t) \leq \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)}t}$	323
$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)}-(p_{20})^{(3)}-(S_2)^{(3)})}\left[e^{((S_1)^{(3)}-(p_{20})^{(3)})t} - e^{-(S_2)^{(3)}t}\right] + G_{22}^0 e^{-(S_2)^{(3)}t} \leq G_{22}(t) \leq\right.$ $\left.\frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)}-(a_{22}')^{(3)})}\left[e^{(S_1)^{(3)}t} - e^{-(a_{22}')^{(3)}t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)}t}\right)$	324
$\boxed{T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}}$	325
$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)}t} \leq T_{20}(t) \leq \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)}+(r_{20})^{(3)})t}$	326
$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)}-(b_{22}')^{(3)})}\left[e^{(R_1)^{(3)}t} - e^{-(b_{22}')^{(3)}t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)}t} \leq T_{22}(t) \leq$ $\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)}+(r_{20})^{(3)}+(R_2)^{(3)})}\left[e^{((R_1)^{(3)}+(r_{20})^{(3)})t} - e^{-(R_2)^{(3)}t}\right] + T_{22}^0 e^{-(R_2)^{(3)}t}$	327
Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ $(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ $(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ $(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$	328
Behavior of the solutions of equation **Theorem:** If we denote and define **Definition of** $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$: $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying $-(\sigma_2)^{(4)} \leq -(a_{24}')^{(4)} + (a_{25}')^{(4)} - (a_{24}'')^{(4)}(T_{25}, t) + (a_{25}'')^{(4)}(T_{25}, t) \leq -(\sigma_1)^{(4)}$ $-(\tau_2)^{(4)} \leq -(b_{24}')^{(4)} + (b_{25}')^{(4)} - (b_{24}'')^{(4)}((G_{27}), t) - (b_{25}'')^{(4)}((G_{27}), t) \leq -(\tau_1)^{(4)}$	
Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: By $(\nu_1)^{(4)} > 0, (\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0, (u_2)^{(4)} < 0$ the roots of the equations	329

$(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and	
Definition of $(\bar{\nu}_1)^{(4)},, (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$ and $(b_{25})^{(4)}\left(u^{(4)}\right)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ **Definition of** $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:- If we define $(m_1)^{(4)}$, $(m_2)^{(4)}$, $(\mu_1)^{(4)}, (\mu_2)^{(4)}$ by $(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)},$ ***if*** $(\nu_0)^{(4)} < (\nu_1)^{(4)}$ $(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, ***if*** $(\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$, and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$ $(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)},$ ***if*** $(\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$	330
and analogously $(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)},$ ***if*** $(u_0)^{(4)} < (u_1)^{(4)}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, ***if*** $(u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$, and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$ $(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)},$ ***if*** $(\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$	331
Then the solution of global equations satisfies the inequalities $G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{24}(t) \leq G_{24}^0 e^{(S_1)^{(4)}t}$ where $(p_i)^{(4)}$ is defined by equation	332
$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} \leq G_{25}(t) \leq \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$	333
$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}\left((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)}\right)}\left[e^{\left((S_1)^{(4)} - (p_{24})^{(4)}\right)t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \leq G_{26}(t) \leq\right.$ *(a26)4G240(m2)4(S1)4−(a26′)4e(S1)4t−e−(a26′)4t+ G260e−(a26′)4t*	334
$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq T_{24}^0 e^{\left((R_1)^{(4)} + (r_{24})^{(4)}\right)t}}$	
$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \leq T_{24}(t) \leq \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{\left((R_1)^{(4)} + (r_{24})^{(4)}\right)t}$	335
$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}\left((R_1)^{(4)} - (b_{26}')^{(4)}\right)}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \leq T_{26}(t) \leq$	336

$\frac{(a_{26})^{(4)}T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t}-e^{-(R_2)^{(4)}t}\right]+T_{26}^0e^{-(R_2)^{(4)}t}$	
Definition of $(S_1)^{(4)},(S_2)^{(4)},(R_1)^{(4)},(R_2)^{(4)}$:- Where $(S_1)^{(4)}=(a_{24})^{(4)}(m_2)^{(4)}-(a_{24}^{'})^{(4)}$ $(S_2)^{(4)}=(a_{26})^{(4)}-(p_{26})^{(4)}$ $(R_1)^{(4)}=(b_{24})^{(4)}(\mu_2)^{(4)}-(b_{24}^{'})^{(4)}$ $(R_2)^{(4)}=(b_{26}^{'})^{(4)}-(r_{26})^{(4)}$	337
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$: $(\sigma_1)^{(5)},(\sigma_2)^{(5)},(\tau_1)^{(5)},(\tau_2)^{(5)}$ four constants satisfying $-(\sigma_2)^{(5)}\leq-(a_{28}^{'})^{(5)}+(a_{29}^{'})^{(5)}-(a_{28}^{''})^{(5)}(T_{29},t)+(a_{29}^{''})^{(5)}(T_{29},t)\leq-(\sigma_1)^{(5)}$ $-(\tau_2)^{(5)}\leq-(b_{28}^{'})^{(5)}+(b_{29}^{'})^{(5)}-(b_{28}^{''})^{(5)}((G_{31}),t)-(b_{29}^{''})^{(5)}((G_{31}),t)\leq-(\tau_1)^{(5)}$	338
Definition of $(\nu_1)^{(5)},(\nu_2)^{(5)},(u_1)^{(5)},(u_2)^{(5)},\nu^{(5)},u^{(5)}$: By $(\nu_1)^{(5)}>0,(\nu_2)^{(5)}<0$ and respectively $(u_1)^{(5)}>0,(u_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_1)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_1)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ and	339
Definition of $(\bar{\nu}_1)^{(5)},,(\bar{\nu}_2)^{(5)},(\bar{u}_1)^{(5)},(\bar{u}_2)^{(5)}$: By $(\bar{\nu}_1)^{(5)}>0,(\bar{\nu}_2)^{(5)}<0$ and respectively $(\bar{u}_1)^{(5)}>0,(\bar{u}_2)^{(5)}<0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2+(\sigma_2)^{(5)}\nu^{(5)}-(a_{28})^{(5)}=0$ and $(b_{29})^{(5)}\left(u^{(5)}\right)^2+(\tau_2)^{(5)}u^{(5)}-(b_{28})^{(5)}=0$ **Definition of** $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)},(\nu_0)^{(5)}$:- If we define $(m_1)^{(5)},(m_2)^{(5)},(\mu_1)^{(5)},(\mu_2)^{(5)}$ by $(m_2)^{(5)}=(\nu_0)^{(5)},(m_1)^{(5)}=(\nu_1)^{(5)},\ \boldsymbol{if}\ (\nu_0)^{(5)}<(\nu_1)^{(5)}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\bar{\nu}_1)^{(5)},\boldsymbol{if}\ (\nu_1)^{(5)}<(\nu_0)^{(5)}<(\bar{\nu}_1)^{(5)}$, and $\boxed{(\nu_0)^{(5)}=\frac{G_{28}^0}{G_{29}^0}}$ $(m_2)^{(5)}=(\nu_1)^{(5)},(m_1)^{(5)}=(\nu_0)^{(5)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(5)}<(\nu_0)^{(5)}$	340
and analogously	341

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)}$, $\boldsymbol{if}$ $(u_0)^{(5)} < (u_1)^{(5)}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}$, $\boldsymbol{if}$ $(u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)}$, and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$ $(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}$, $\boldsymbol{if}$ $(\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$	
Then the solution of global equations satisfies the inequalities $G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{28}(t) \leq G_{28}^0 e^{(S_1)^{(5)} t}$ where $(p_i)^{(5)}$ is defined by equation	342
$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \leq G_{29}(t) \leq \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)} t}$	343
$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)} t}\right] + G_{30}^0 e^{-(S_2)^{(5)} t} \leq G_{30}(t) \leq\right.$ *(a30)5G280(m2)5(S1)5−(a30′)5e(S1)5t−e−(a30′)5t+ G300e−(a30′)5t*	344
$\boxed{T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}}$	345
$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)} t} \leq T_{28}(t) \leq \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}$	346
$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b_{30}')^{(5)})}\left[e^{(R_1)^{(5)} t} - e^{-(b_{30}')^{(5)} t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)} t} \leq T_{30}(t) \leq$ $\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)} t}\right] + T_{30}^0 e^{-(R_2)^{(5)} t}$	347
<u>**Definition of**</u> $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$ $(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$ $(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$ $(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$	348
<u>**Behavior of the solutions of equation**</u> <u>**Theorem 2:**</u> If we denote and define <u>**Definition of**</u> $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$: $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying	349

$-(\sigma_2)^{(6)} \leq -(a'_{32})^{(6)} + (a'_{33})^{(6)} - (a''_{32})^{(6)}(T_{33},t) + (a''_{33})^{(6)}(T_{33},t) \leq -(\sigma_1)^{(6)}$ $-(\tau_2)^{(6)} \leq -(b'_{32})^{(6)} + (b'_{33})^{(6)} - (b''_{32})^{(6)}((G_{35}),t) - (b''_{33})^{(6)}((G_{35}),t) \leq -(\tau_1)^{(6)}$	
Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and	350
Definition of $(\bar{\nu}_1)^{(6)},, (\bar{\nu}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: By $(\bar{\nu}_1)^{(6)} > 0$, $(\bar{\nu}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}(\nu^{(6)})^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)} = 0$ and $(b_{33})^{(6)}(u^{(6)})^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ **Definition of** $(m_1)^{(6)}$, $(m_2)^{(6)}$, $(\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:- If we define $(m_1)^{(6)}$, $(m_2)^{(6)}$, $(\mu_1)^{(6)}, (\mu_2)^{(6)}$ by $(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)},$ ***if*** $(\nu_0)^{(6)} < (\nu_1)^{(6)}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}$, ***if*** $(\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$ $(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)},$ ***if*** $(\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$	351
and analogously $(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)},$ ***if*** $(u_0)^{(6)} < (u_1)^{(6)}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}$, ***if*** $(u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$, and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$ $(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)},$ ***if*** $(\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$	352
Then the solution of global equations satisfies the inequalities $G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{32}(t) \leq G_{32}^0 e^{(S_1)^{(6)}t}$ where $(p_i)^{(6)}$ is defined by equation	353
$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)}-(p_{32})^{(6)})t} \leq G_{33}(t) \leq \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t}$	354
$\left(\frac{(a_{34})^{(6)}G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)}-(p_{32})^{(6)}-(S_2)^{(6)})}\left[e^{((S_1)^{(6)}-(p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \leq G_{34}(t) \leq\right.$ *(a34)6G320(m2)6(S1)6−(a34′)6e(S1)6t−e−(a34′)6t+ G340e−(a34′)6t*	355

$T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	356
$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \leq T_{32}(t) \leq \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)}+(r_{32})^{(6)})t}$	357
$\frac{(b_{34})^{(6)}T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)}-(b_{34}')^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b_{34}')^{(6)}t}\right] + T_{34}^0 e^{-(b_{34}')^{(6)}t} \leq T_{34}(t) \leq$ $\frac{(a_{34})^{(6)}T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)}+(r_{32})^{(6)}+(R_2)^{(6)})}\left[e^{((R_1)^{(6)}+(r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$	358
Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a_{32}')^{(6)}$ $(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$ $(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b_{32}')^{(6)}$ $(R_2)^{(6)} = (b_{34}')^{(6)} - (r_{34})^{(6)}$	359
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying $-(\sigma_2)^{(7)} \leq -(a_{36}')^{(7)} + (a_{37}')^{(7)} - (a_{36}'')^{(7)}(T_{37}, t) + (a_{37}'')^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$ $-(\tau_2)^{(7)} \leq -(b_{36}')^{(7)} + (b_{37}')^{(7)} - (b_{36}'')^{(7)}((G_{39}), t) - (b_{37}'')^{(7)}((G_{39}), t) \leq -(\tau_1)^{(7)}$	
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$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},\ \boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}\ , \boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$ and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ $(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$	
and analogously $(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},\ \boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}\ , \boldsymbol{if}\ (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$ and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ $(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}\ (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$	363
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$\frac{1}{(m_7)^{(7)}} G_{36}^0\, e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0\, e^{(S_1)^{(7)}t}$	365
$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0\, e^{-(S_2)^{(7)}t} \leq G_{38}(t) \leq\right.$ $\left.\frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}')^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a_{38}')^{(7)}t}\right] + G_{38}^0\, e^{-(a_{38}')^{(7)}t}\right)$	366
$\boxed{T_{36}^0\, e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0\, e^{((R_1)^{(7)}+(r_{36})^{(7)})t}}$	367
$\frac{1}{(\mu_1)^{(7)}} T_{36}^0\, e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0\, e^{((R_1)^{(7)}+(r_{36})^{(7)})t}$	368
$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}')^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}')^{(7)}t}\right] + T_{38}^0\, e^{-(b_{38}')^{(7)}t} \leq T_{38}(t) \leq$ $\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0\, e^{-(R_2)^{(7)}t}$	369
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$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$ $(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)}$ $(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$	
Behavior of the solutions of equation **Theorem 2:** If we denote and define **Definition of** $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$: $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying $-(\sigma_2)^{(8)} \leq -(a_{40}^{'})^{(8)} + (a_{41}^{'})^{(8)} - (a_{40}^{''})^{(8)}(T_{41}, t) + (a_{41}^{''})^{(8)}(T_{41}, t) \leq -(\sigma_1)^{(8)}$ $-(\tau_2)^{(8)} \leq -(b_{40}^{'})^{(8)} + (b_{41}^{'})^{(8)} - (b_{40}^{''})^{(8)}\big((G_{43}), t\big) - (b_{41}^{''})^{(8)}\big((G_{43}), t\big) \leq -(\tau_1)^{(8)}$	371
Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: By $(\nu_1)^{(8)} > 0, (\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0, (u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and	372
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and analogously $(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)}, \;\boldsymbol{if}\; (u_0)^{(8)} < (u_1)^{(8)}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)} \;, \boldsymbol{if}\; (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$ and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$ $(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\; (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$	374
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$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \leq G_{41}(t) \leq \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)} t}$	376
$\Big(\frac{(a_{42})^{(8)} G_{40}^0}{(m_1)^{(8)}((S_1)^{(8)} - (p_{40})^{(8)} - (S_2)^{(8)})} \left[e^{((S_1)^{(8)} - (p_{40})^{(8)})t} - e^{-(S_2)^{(8)} t}\right] + G_{42}^0 e^{-(S_2)^{(8)} t} \leq G_{42}(t) \leq$ $\frac{(a_{42})^{(8)} G_{40}^0}{(m_2)^{(8)}((S_1)^{(8)} - (a_{42}')^{(8)})} [e^{(S_1)^{(8)} t} - e^{-(a_{42}')^{(8)} t}] + G_{42}^0 e^{-(a_{42}')^{(8)} t}\Big)$	377
$\boxed{T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}}$	378
$\frac{1}{(\mu_1)^{(8)}} T_{40}^0 e^{(R_1)^{(8)} t} \leq T_{40}(t) \leq \frac{1}{(\mu_2)^{(8)}} T_{40}^0 e^{((R_1)^{(8)} + (r_{40})^{(8)})t}$	379
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<u>**Definition of**</u> $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- Where $(S_1)^{(8)} = (a_{40})^{(8)}(m_2)^{(8)} - (a_{40}')^{(8)}$ $(S_2)^{(8)} = (a_{42})^{(8)} - (p_{42})^{(8)}$ $(R_1)^{(8)} = (b_{40})^{(8)}(\mu_2)^{(8)} - (b_{40}')^{(8)}$ $(R_2)^{(8)} = (b_{42}')^{(8)} - (r_{42})^{(8)}$	381
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Definition of $(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$:

$(\sigma_1)^{(9)}, (\sigma_2)^{(9)}, (\tau_1)^{(9)}, (\tau_2)^{(9)}$ four constants satisfying

$$-(\sigma_2)^{(9)} \leq -(a'_{44})^{(9)} + (a'_{45})^{(9)} - (a''_{44})^{(9)}(T_{45}, t) + (a''_{45})^{(9)}(T_{45}, t) \leq -(\sigma_1)^{(9)}$$

$$-(\tau_2)^{(9)} \leq -(b'_{44})^{(9)} + (b'_{45})^{(9)} - (b''_{44})^{(9)}\big((G_{47}), t\big) - (b''_{45})^{(9)}\big((G_{47}), t\big) \leq -(\tau_1)^{(9)}$$

Definition of $(\nu_1)^{(9)}, (\nu_2)^{(9)}, (u_1)^{(9)}, (u_2)^{(9)}, \nu^{(9)}, u^{(9)}$:

By $(\nu_1)^{(9)} > 0, (\nu_2)^{(9)} < 0$ and respectively $(u_1)^{(9)} > 0, (u_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_1)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$ and

Definition of $(\bar{\nu}_1)^{(9)},, (\bar{\nu}_2)^{(9)}, (\bar{u}_1)^{(9)}, (\bar{u}_2)^{(9)}$:

By $(\bar{\nu}_1)^{(9)} > 0, (\bar{\nu}_2)^{(9)} < 0$ and respectively $(\bar{u}_1)^{(9)} > 0, (\bar{u}_2)^{(9)} < 0$ the roots of the equations $(a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)} = 0$

and $(b_{45})^{(9)}\left(u^{(9)}\right)^2 + (\tau_2)^{(9)}u^{(9)} - (b_{44})^{(9)} = 0$

Definition of $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}, (\nu_0)^{(9)}$:-

If we define $(m_1)^{(9)}, (m_2)^{(9)}, (\mu_1)^{(9)}, (\mu_2)^{(9)}$ by

$$(m_2)^{(9)} = (\nu_0)^{(9)}, (m_1)^{(9)} = (\nu_1)^{(9)}, \; \boldsymbol{if} \; (\nu_0)^{(9)} < (\nu_1)^{(9)}$$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\bar{\nu}_1)^{(9)}, \boldsymbol{if} \; (\nu_1)^{(9)} < (\nu_0)^{(9)} < (\bar{\nu}_1)^{(9)},$$

and $\boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$

$$(m_2)^{(9)} = (\nu_1)^{(9)}, (m_1)^{(9)} = (\nu_0)^{(9)}, \; \boldsymbol{if} \; (\bar{\nu}_1)^{(9)} < (\nu_0)^{(9)}$$

and analogously

$$(\mu_2)^{(9)} = (u_0)^{(9)}, (\mu_1)^{(9)} = (u_1)^{(9)}, \; \boldsymbol{if} \; (u_0)^{(9)} < (u_1)^{(9)}$$

$$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (\bar{u}_1)^{(9)}, \boldsymbol{if} \; (u_1)^{(9)} < (u_0)^{(9)} < (\bar{u}_1)^{(9)},$$

and $\boxed{(u_0)^{(9)} = \frac{T_{44}^0}{T_{45}^0}}$

$(\mu_2)^{(9)} = (u_1)^{(9)}, (\mu_1)^{(9)} = (u_0)^{(9)}, \boldsymbol{if} \; (\bar{u}_1)^{(9)} < (u_0)^{(9)}$ where $(u_1)^{(9)}, (\bar{u}_1)^{(9)}$ are defined by 59 and 69 respectively

Then the solution of 19,20,21,22,23 and 24 satisfies the inequalities

$$G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \leq G_{44}(t) \leq G_{44}^0 e^{(S_1)^{(9)}t}$$

where $(p_i)^{(9)}$ is defined by equation 45

$$\frac{1}{(m_9)^{(9)}} G_{44}^0 e^{\left((S_1)^{(9)} - (p_{44})^{(9)}\right)t} \leq G_{45}(t) \leq \frac{1}{(m_2)^{(9)}} G_{44}^0 e^{(S_1)^{(9)}t}$$

$\left(\frac{(a_{46})^{(9)} G_{44}^0}{(m_1)^{(9)}((S_1)^{(9)}-(p_{44})^{(9)}-(S_2)^{(9)})} \left[e^{((S_1)^{(9)}-(p_{44})^{(9)})t} - e^{-(S_2)^{(9)}t} \right] + G_{46}^0 e^{-(S_2)^{(9)}t} \leq G_{46}(t) \leq \frac{(a_{46})^{(9)} G_{44}^0}{(m_2)^{(9)}((S_1)^{(9)}-(a_{46}')^{(9)})} [e^{(S_1)^{(9)}t} - e^{-(a_{46}')^{(9)}t}] + G_{46}^0 e^{-(a_{46}')^{(9)}t} \right)$	
$\boxed{T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}}$	
$\frac{1}{(\mu_1)^{(9)}} T_{44}^0 e^{(R_1)^{(9)}t} \leq T_{44}(t) \leq \frac{1}{(\mu_2)^{(9)}} T_{44}^0 e^{((R_1)^{(9)}+(r_{44})^{(9)})t}$	
$\frac{(b_{46})^{(9)} T_{44}^0}{(\mu_1)^{(9)}((R_1)^{(9)}-(b_{46}')^{(9)})} \left[e^{(R_1)^{(9)}t} - e^{-(b_{46}')^{(9)}t} \right] + T_{46}^0 e^{-(b_{46}')^{(9)}t} \leq T_{46}(t) \leq \frac{(a_{46})^{(9)} T_{44}^0}{(\mu_2)^{(9)}((R_1)^{(9)}+(r_{44})^{(9)}+(R_2)^{(9)})} \left[e^{((R_1)^{(9)}+(r_{44})^{(9)})t} - e^{-(R_2)^{(9)}t} \right] + T_{46}^0 e^{-(R_2)^{(9)}t}$	
<u>**Definition of**</u> $(S_1)^{(9)}, (S_2)^{(9)}, (R_1)^{(9)}, (R_2)^{(9)}$:- Where $(S_1)^{(9)} = (a_{44})^{(9)}(m_2)^{(9)} - (a_{44}')^{(9)}$; $(S_2)^{(9)} = (a_{46})^{(9)} - (p_{46})^{(9)}$; $(R_1)^{(9)} = (b_{44})^{(9)}(\mu_2)^{(9)} - (b_{44}')^{(9)}$; $(R_2)^{(9)} = (b_{46}')^{(9)} - (r_{46})^{(9)}$	

Proof : From global equations we obtain $\frac{d\nu^{(1)}}{dt} = (a_{13})^{(1)} - \left((a_{13}')^{(1)} - (a_{14}')^{(1)} + (a_{13}'')^{(1)}(T_{14},t)\right) - (a_{14}'')^{(1)}(T_{14},t)\nu^{(1)} - (a_{14})^{(1)}\nu^{(1)}$ **Definition of** $\nu^{(1)}$:- $\boxed{\nu^{(1)} = \frac{G_{13}}{G_{14}}}$ It follows $-\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_2)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right) \le \frac{d\nu^{(1)}}{dt} \le -\left((a_{14})^{(1)}\left(\nu^{(1)}\right)^2 + (\sigma_1)^{(1)}\nu^{(1)} - (a_{13})^{(1)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(1)}, (\nu_0)^{(1)}$:- For $0 < \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}} < (\nu_1)^{(1)} < (\bar{\nu}_1)^{(1)}$ $\nu^{(1)}(t) \ge \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_0)^{(1)}\right)t\right]}}$, $\boxed{(C)^{(1)} = \frac{(\nu_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\nu_2)^{(1)}}}$ it follows $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\nu_1)^{(1)}$	383
In the same manner , we get $\nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}$, $\boxed{(\bar{C})^{(1)} = \frac{(\bar{\nu}_1)^{(1)} - (\nu_0)^{(1)}}{(\nu_0)^{(1)} - (\bar{\nu}_2)^{(1)}}}$ From which we deduce $(\nu_0)^{(1)} \le \nu^{(1)}(t) \le (\bar{\nu}_1)^{(1)}$	384
If $0 < (\nu_1)^{(1)} < (\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0} < (\bar{\nu}_1)^{(1)}$ we find like in the previous case, $(\nu_1)^{(1)} \le \frac{(\nu_1)^{(1)} + (C)^{(1)}(\nu_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}}{1 + (C)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\nu_1)^{(1)} - (\nu_2)^{(1)}\right)t\right]}} \le \nu^{(1)}(t) \le$ $\frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\bar{\nu}_1)^{(1)}$	385
If $0 < (\nu_1)^{(1)} \le (\bar{\nu}_1)^{(1)} \le \boxed{(\nu_0)^{(1)} = \frac{G_{13}^0}{G_{14}^0}}$, we obtain $(\nu_1)^{(1)} \le \nu^{(1)}(t) \le \frac{(\bar{\nu}_1)^{(1)} + (\bar{C})^{(1)}(\bar{\nu}_2)^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}}{1 + (\bar{C})^{(1)} e^{\left[-(a_{14})^{(1)}\left((\bar{\nu}_1)^{(1)} - (\bar{\nu}_2)^{(1)}\right)t\right]}} \le (\nu_0)^{(1)}$ And so with the notation of the first part of condition (c) , we have	386

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$\nu^{(2)}(t) \leq \frac{(\bar{\nu}_1)^{(2)}+(\bar{C})^{(2)}(\bar{\nu}_2)^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}{1+(\bar{C})^{(2)}e^{\left[-(a_{17})^{(2)}\left((\bar{\nu}_1)^{(2)}-(\bar{\nu}_2)^{(2)}\right)t\right]}}$, $\boxed{(\bar{C})^{(2)} = \frac{(\bar{\nu}_1)^{(2)}-(\nu_0)^{(2)}}{(\nu_0)^{(2)}-(\bar{\nu}_2)^{(2)}}}$	
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<u>Definition of</u> $\nu^{(3)}$:- $\boxed{\nu^{(3)} = \frac{G_{20}}{G_{21}}}$ It follows $-\left((a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right) \leq \frac{d\nu^{(3)}}{dt} \leq -\left((a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)}\right)$	399
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$(m_2)^{(3)} \leq \nu^{(3)}(t) \leq (m_1)^{(3)}$, $\boxed{\nu^{(3)}(t) = \frac{G_{20}(t)}{G_{21}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(3)}(t)$:-

$(\mu_2)^{(3)} \leq u^{(3)}(t) \leq (\mu_1)^{(3)}$, $\boxed{u^{(3)}(t) = \frac{T_{20}(t)}{T_{21}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{20})^{(3)} = (a''_{21})^{(3)}, then\ (\sigma_1)^{(3)} = (\sigma_2)^{(3)}$ and in this case $(\nu_1)^{(3)} = (\bar{\nu}_1)^{(3)}$ if in addition $(\nu_0)^{(3)} = (\nu_1)^{(3)}$ then $\nu^{(3)}(t) = (\nu_0)^{(3)}$ and as a consequence $G_{20}(t) = (\nu_0)^{(3)} G_{21}(t)$

Analogously if $(b''_{20})^{(3)} = (b''_{21})^{(3)}, then\ (\tau_1)^{(3)} = (\tau_2)^{(3)}$ and then

$(u_1)^{(3)} = (\bar{u}_1)^{(3)}$if in addition $(u_0)^{(3)} = (u_1)^{(3)}$ then $T_{20}(t) = (u_0)^{(3)} T_{21}(t)$ This is an important consequence of the relation between $(\nu_1)^{(3)}$ and $(\bar{\nu}_1)^{(3)}$

Proof : From global equations we obtain 404

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a'_{24})^{(4)} - (a'_{25})^{(4)} + (a''_{24})^{(4)}(T_{25}, t)\right) - (a''_{25})^{(4)}(T_{25}, t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

For $0 < \boxed{(\nu_0)^{(4)} = \frac{G^0_{24}}{G^0_{25}}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 405

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 406

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)}+(C)^{(4)}(\nu_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}}{1+(C)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)}-(\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 407

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)}+(\bar{C})^{(4)}(\bar{\nu}_2)^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}}{1+(\bar{C})^{(4)}e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)}-(\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}, \quad \boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}, \quad \boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{24})^{(4)} = (a''_{25})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition $(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)}G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case** .

Analogously if $(b''_{24})^{(4)} = (b''_{25})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then $(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)}T_{25}(t)$ This is an important consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a'_{28})^{(5)} - (a'_{29})^{(5)} + (a''_{28})^{(5)}(T_{29},t)\right) - (a''_{29})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 409

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{5 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 410

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}}{1 + (C)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 411

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)} e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}, \quad \boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} =$

$(\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case .** Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.	
<u>**Proof**</u> : From global equations we obtain $\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33},t)\right) - (a''_{33})^{(6)}(T_{33},t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$ <u>**Definition of**</u> $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$ It follows $-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$ From which one obtains <u>**Definition of**</u> $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:- For $0 < \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$ $\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}$, $\boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$ it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$	412
In the same manner , we get $\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}$, $\boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}}$ From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$	413
If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, $(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\bar{\nu}_1)^{(6)}$	414
If $0 < (\nu_1)^{(6)} \leq (\bar{\nu}_1)^{(6)} \leq \boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain $(\nu_1)^{(6)} \leq \nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \leq (\nu_0)^{(6)}$	415

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(6)}(t)$:-

$(m_2)^{(6)} \leq \nu^{(6)}(t) \leq (m_1)^{(6)}$, $\boxed{\nu^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}$, $\boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{32})^{(6)} = (a''_{33})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(\nu_1)^{(6)} = (\bar{\nu}_1)^{(6)}$ if in addition $(\nu_0)^{(6)} = (\nu_1)^{(6)}$ then $\nu^{(6)}(t) = (\nu_0)^{(6)}$ and as a consequence $G_{32}(t) = (\nu_0)^{(6)} G_{33}(t)$ **this also defines** $(\nu_0)^{(6)}$ **for the special case .**

Analogously if $(b''_{32})^{(6)} = (b''_{33})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$ if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)} T_{33}(t)$ This is an important consequence of the relation between $(\nu_1)^{(6)}$ and $(\bar{\nu}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Proof : From global equations we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right) - (a''_{37})^{(7)}(T_{37},t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq -\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)} e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 417

$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}$, $\boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$ From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$	
If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, $(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$	418
If $0 < (\nu_1)^{(7)} \leq (\bar{\nu}_1)^{(7)} \leq \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$, we obtain $(\nu_1)^{(7)} \leq \nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\nu_0)^{(7)}$ And so with the notation of the first part of condition (c) , we have **<u>Definition of</u>** $\nu^{(7)}(t)$:- $(m_2)^{(7)} \leq \nu^{(7)}(t) \leq (m_1)^{(7)}$, $\boxed{\nu^{(7)}(t) = \frac{G_{36}(t)}{G_{37}(t)}}$ In a completely analogous way, we obtain	419
<u>Definition of</u> $u^{(7)}(t)$:- $(\mu_2)^{(7)} \leq u^{(7)}(t) \leq (\mu_1)^{(7)}$, $\boxed{u^{(7)}(t) = \frac{T_{36}(t)}{T_{37}(t)}}$ Now, using this result and replacing it in global equations we get easily the result stated in the theorem. **<u>Particular case :</u>** If $(a''_{36})^{(7)} = (a''_{37})^{(7)}, then\ (\sigma_1)^{(7)} = (\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)} = (\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)} = (\nu_1)^{(7)}$ then $\nu^{(7)}(t) = (\nu_0)^{(7)}$ and as a consequence $G_{36}(t) = (\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case .** Analogously if $(b''_{36})^{(7)} = (b''_{37})^{(7)}, then\ (\tau_1)^{(7)} = (\tau_2)^{(7)}$ and then $(u_1)^{(7)} = (\bar{u}_1)^{(7)}$if in addition $(u_0)^{(7)} = (u_1)^{(7)}$ then $T_{36}(t) = (u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.	420

Proof : From global equations we obtain $\frac{d\nu^{(8)}}{dt} = (a_{40})^{(8)} - \left((a'_{40})^{(8)} - (a'_{41})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right) - (a''_{41})^{(8)}(T_{41},t)\nu^{(8)} - (a_{41})^{(8)}\nu^{(8)}$ **Definition of** $\nu^{(8)}$:- $\boxed{\nu^{(8)} = \frac{G_{40}}{G_{41}}}$ It follows $-\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right) \leq \frac{d\nu^{(8)}}{dt} \leq -\left((a_{41})^{(8)}\left(\nu^{(8)}\right)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)}\right)$ From which one obtains **Definition of** $(\bar{\nu}_1)^{(8)}, (\nu_0)^{(8)}$:- For $0 < \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}} < (\nu_1)^{(8)} < (\bar{\nu}_1)^{(8)}$ $\nu^{(8)}(t) \geq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}{1 + (C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_0)^{(8)}\right)t\right]}}$, $\boxed{(C)^{(8)} = \frac{(\nu_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\nu_2)^{(8)}}}$ it follows $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\nu_1)^{(8)}$	421
In the same manner , we get $\nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}$, $\boxed{(\bar{C})^{(8)} = \frac{(\bar{\nu}_1)^{(8)} - (\nu_0)^{(8)}}{(\nu_0)^{(8)} - (\bar{\nu}_2)^{(8)}}}$ From which we deduce $(\nu_0)^{(8)} \leq \nu^{(8)}(t) \leq (\bar{\nu}_8)^{(8)}$	422
If $0 < (\nu_1)^{(8)} < (\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0} < (\bar{\nu}_1)^{(8)}$ we find like in the previous case, $(\nu_1)^{(8)} \leq \frac{(\nu_1)^{(8)} + (C)^{(8)}(\nu_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}}{1 + (C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\nu_1)^{(8)} - (\nu_2)^{(8)}\right)t\right]}} \leq \nu^{(8)}(t) \leq$ $\frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\bar{\nu}_1)^{(8)}$	423
If $0 < (\nu_1)^{(8)} \leq (\bar{\nu}_1)^{(8)} \leq \boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$, we obtain $(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)} + (\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}}{1 + (\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)} - (\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$ And so with the notation of the first part of condition (c) , we have **Definition of** $\nu^{(8)}(t)$:-	424

$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}$, $\boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}$, $\boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$

Now, using this result and replacing it in global equations we get easily the result stated in the theorem.

Particular case :

If $(a''_{40})^{(8)} = (a''_{41})^{(8)}$, *then* $(\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)} G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case .**

Analogously if $(b''_{40})^{(8)} = (b''_{41})^{(8)}$, *then* $(\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then $(u_1)^{(8)} = (\bar{u}_1)^{(8)}$ if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)} T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

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Proof : From 99,20,44,22,23,44 we obtain

$$\frac{d\nu^{(9)}}{dt} = (a_{44})^{(9)} - \left((a'_{44})^{(9)} - (a'_{45})^{(9)} + (a''_{44})^{(9)}(T_{45},t)\right) - (a''_{45})^{(9)}(T_{45},t)\nu^{(9)} - (a_{45})^{(9)}\nu^{(9)}$$

Definition of $\nu^{(9)}$:- $\boxed{\nu^{(9)} = \frac{G_{44}}{G_{45}}}$

It follows

$$-\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_2)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right) \leq \frac{d\nu^{(9)}}{dt} \leq -\left((a_{45})^{(9)}\left(\nu^{(9)}\right)^2 + (\sigma_1)^{(9)}\nu^{(9)} - (a_{44})^{(9)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(9)}, (\nu_0)^{(9)}$:-

For $0 < \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}} < (\nu_1)^{(9)} < (\bar{\nu}_1)^{(9)}$

$$\nu^{(9)}(t) \geq \frac{(\nu_1)^{(9)} + (C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}}{1 + (C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)} - (\nu_0)^{(9)}\right)t\right]}} \quad , \quad \boxed{(C)^{(9)} = \frac{(\nu_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\nu_2)^{(9)}}}$$

it follows $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\nu_9)^{(9)}$

In the same manner , we get

$$\nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)} + (\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}}{1 + (\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)} - (\bar{\nu}_2)^{(9)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(9)} = \frac{(\bar{\nu}_1)^{(9)} - (\nu_0)^{(9)}}{(\nu_0)^{(9)} - (\bar{\nu}_2)^{(9)}}}$$

From which we deduce $(\nu_0)^{(9)} \leq \nu^{(9)}(t) \leq (\bar{\nu}_1)^{(9)}$

If $0 < (\nu_1)^{(9)} < (\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0} < (\bar{\nu}_1)^{(9)}$ we find like in the previous case,

$$(\nu_1)^{(9)} \leq \frac{(\nu_1)^{(9)}+(C)^{(9)}(\nu_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}}{1+(C)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\nu_1)^{(9)}-(\nu_2)^{(9)}\right)t\right]}} \leq \nu^{(9)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\bar{\nu}_1)^{(9)}$$

If $0 < (\nu_1)^{(9)} \leq (\bar{\nu}_1)^{(9)} \leq \boxed{(\nu_0)^{(9)} = \frac{G_{44}^0}{G_{45}^0}}$, we obtain

$$(\nu_1)^{(9)} \leq \nu^{(9)}(t) \leq \frac{(\bar{\nu}_1)^{(9)}+(\bar{C})^{(9)}(\bar{\nu}_2)^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}}{1+(\bar{C})^{(9)} e^{\left[-(a_{45})^{(9)}\left((\bar{\nu}_1)^{(9)}-(\bar{\nu}_2)^{(9)}\right)t\right]}} \leq (\nu_0)^{(9)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(9)}(t)$:-

$$(m_2)^{(9)} \leq \nu^{(9)}(t) \leq (m_1)^{(9)}, \quad \boxed{\nu^{(9)}(t) = \frac{G_{44}(t)}{G_{45}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(9)}(t)$:-

$$(\mu_2)^{(9)} \leq u^{(9)}(t) \leq (\mu_1)^{(9)}, \quad \boxed{u^{(9)}(t) = \frac{T_{44}(t)}{T_{45}(t)}}$$

Now, using this result and replacing it in 99, 20,44,22,23, and 44 we get easily the result stated in the theorem.

Particular case :

If $(a''_{44})^{(9)} = (a''_{45})^{(9)}, then\ (\sigma_1)^{(9)} = (\sigma_2)^{(9)}$ and in this case $(\nu_1)^{(9)} = (\bar{\nu}_1)^{(9)}$ if in addition $(\nu_0)^{(9)} = (\nu_1)^{(9)}$ then $\nu^{(9)}(t) = (\nu_0)^{(9)}$ and as a consequence $G_{44}(t) = (\nu_0)^{(9)} G_{45}(t)$ **this also defines** $(\nu_0)^{(9)}$ **for the special case .**

Analogously if $(b''_{44})^{(9)} = (b''_{45})^{(9)}, then\ (\tau_1)^{(9)} = (\tau_2)^{(9)}$ and then $(u_1)^{(9)} = (\bar{u}_1)^{(9)}$if in addition $(u_0)^{(9)} = (u_1)^{(9)}$ then $T_{44}(t) = (u_0)^{(9)} T_{45}(t)$ This is an important consequence of the relation between $(\nu_1)^{(9)}$ and $(\bar{\nu}_1)^{(9)}$, **and definition of** $(u_0)^{(9)}$.

We can prove the following 425

Theorem : If $(a''_i)^{(1)} and\ (b''_i)^{(1)}$ are independent on t , and the conditions with the notations

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} < 0$$

$$(a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a_{13})^{(1)}(p_{13})^{(1)} + (a'_{14})^{(1)}(p_{14})^{(1)} + (p_{13})^{(1)}(p_{14})^{(1)} > 0$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} > 0 ,$$

$$(b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} - (b'_{13})^{(1)}(r_{14})^{(1)} - (b'_{14})^{(1)}(r_{14})^{(1)} + (r_{13})^{(1)}(r_{14})^{(1)} < 0$$

with $(p_{13})^{(1)}, (r_{14})^{(1)}$ as defined by equation are satisfied , then the system	
Theorem : If $(a_i^{''})^{(2)} and\ (b_i^{''})^{(2)}$ are independent on t , and the conditions with the notations	426
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} < 0$	427
$(a_{16}^{'})^{(2)}(a_{17}^{'})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a_{16})^{(2)}(p_{16})^{(2)} + (a_{17}^{'})^{(2)}(p_{17})^{(2)} + (p_{16})^{(2)}(p_{17})^{(2)} > 0$	428
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} > 0$,	429
$(b_{16}^{'})^{(2)}(b_{17}^{'})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} - (b_{16}^{'})^{(2)}(r_{17})^{(2)} - (b_{17}^{'})^{(2)}(r_{17})^{(2)} + (r_{16})^{(2)}(r_{17})^{(2)} < 0$ *with* $(p_{16})^{(2)}, (r_{17})^{(2)}$ as defined by equation are satisfied , then the system	430
Theorem : If $(a_i^{''})^{(3)} and\ (b_i^{''})^{(3)}$ are independent on t , and the conditions with the notations $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} < 0$ $(a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20})^{(3)}(p_{20})^{(3)} + (a_{21}^{'})^{(3)}(p_{21})^{(3)} + (p_{20})^{(3)}(p_{21})^{(3)} > 0$ $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} > 0$, $(b_{20}^{'})^{(3)}(b_{21}^{'})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} - (b_{20}^{'})^{(3)}(r_{21})^{(3)} - (b_{21}^{'})^{(3)}(r_{21})^{(3)} + (r_{20})^{(3)}(r_{21})^{(3)} < 0$ *with* $(p_{20})^{(3)}, (r_{21})^{(3)}$ as defined by equation are satisfied , then the system	431
We can prove the following **Theorem** : If $(a_i^{''})^{(4)} and\ (b_i^{''})^{(4)}$ are independent on t , and the conditions with the notations $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} < 0$ $(a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24})^{(4)}(p_{24})^{(4)} + (a_{25}^{'})^{(4)}(p_{25})^{(4)} + (p_{24})^{(4)}(p_{25})^{(4)} > 0$ $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} > 0$, $(b_{24}^{'})^{(4)}(b_{25}^{'})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} - (b_{24}^{'})^{(4)}(r_{25})^{(4)} - (b_{25}^{'})^{(4)}(r_{25})^{(4)} + (r_{24})^{(4)}(r_{25})^{(4)} < 0$ *with* $(p_{24})^{(4)}, (r_{25})^{(4)}$ as defined by equation are satisfied , then the system	432
Theorem : If $(a_i^{''})^{(5)} and\ (b_i^{''})^{(5)}$ are independent on t , and the conditions with the notations $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} < 0$ $(a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28})^{(5)}(p_{28})^{(5)} + (a_{29}^{'})^{(5)}(p_{29})^{(5)} + (p_{28})^{(5)}(p_{29})^{(5)} > 0$ $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} > 0$, $(b_{28}^{'})^{(5)}(b_{29}^{'})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} - (b_{28}^{'})^{(5)}(r_{29})^{(5)} - (b_{29}^{'})^{(5)}(r_{29})^{(5)} + (r_{28})^{(5)}(r_{29})^{(5)} < 0$ *with* $(p_{28})^{(5)}, (r_{29})^{(5)}$ as defined by equation are satisfied , then the system	433

Theorem If $(a_i'')^{(6)} and\ (b_i'')^{(6)}$ are independent on t , and the conditions with the notations $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} < 0$ $(a_{32}')^{(6)}(a_{33}')^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32})^{(6)}(p_{32})^{(6)} + (a_{33}')^{(6)}(p_{33})^{(6)} + (p_{32})^{(6)}(p_{33})^{(6)} > 0$ $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} > 0$, $(b_{32}')^{(6)}(b_{33}')^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} - (b_{32}')^{(6)}(r_{33})^{(6)} - (b_{33}')^{(6)}(r_{33})^{(6)} + (r_{32})^{(6)}(r_{33})^{(6)} < 0$ $with\ (p_{32})^{(6)}, (r_{33})^{(6)}$ as defined by equation are satisfied , then the system	434
Theorem : If $(a_i'')^{(7)} and\ (b_i'')^{(7)}$ are independent on t , and the conditions with the notations $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ $(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$ $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$, $(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$ $with\ (p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation are satisfied , then the system	435
Theorem : If $(a_i'')^{(8)} and\ (b_i'')^{(8)}$ are independent on t , and the conditions with the notations $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} < 0$ $(a_{40}')^{(8)}(a_{41}')^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40})^{(8)}(p_{40})^{(8)} + (a_{41}')^{(8)}(p_{41})^{(8)} + (p_{40})^{(8)}(p_{41})^{(8)} > 0$ $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} > 0$, $(b_{40}')^{(8)}(b_{41}')^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} - (b_{40}')^{(8)}(r_{41})^{(8)} - (b_{41}')^{(8)}(r_{41})^{(8)} + (r_{40})^{(8)}(r_{41})^{(8)} < 0$ $with\ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined by equation are satisfied , then the system	436
Theorem : If $(a_i'')^{(9)} and\ (b_i'')^{(9)}$ are independent on t , and the conditions (with the notations 45,46,27,28) $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} < 0$ $(a_{44}')^{(9)}(a_{45}')^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44})^{(9)}(p_{44})^{(9)} + (a_{45}')^{(9)}(p_{45})^{(9)} + (p_{44})^{(9)}(p_{45})^{(9)} > 0$ $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} > 0$, $(b_{44}')^{(9)}(b_{45}')^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} - (b_{44}')^{(9)}(r_{45})^{(9)} - (b_{45}')^{(9)}(r_{45})^{(9)} + (r_{44})^{(9)}(r_{45})^{(9)} < 0$	436 A

$with\ (p_{44})^{(9)}, (r_{45})^{(9)}$ as defined by equation 45 are satisfied , then the system	
$(a_{13})^{(1)}G_{14} - [(a_{13}^{'})^{(1)} + (a_{13}^{''})^{(1)}(T_{14})]G_{13} = 0$	437
$(a_{14})^{(1)}G_{13} - [(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14})]G_{14} = 0$	438
$(a_{15})^{(1)}G_{14} - [(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14})]G_{15} = 0$	439
$(b_{13})^{(1)}T_{14} - [(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G)\ ]T_{13} = 0$	440
$(b_{14})^{(1)}T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\ ]T_{14} = 0$	441
$(b_{15})^{(1)}T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\ ]T_{15} = 0$	442
has a unique positive solution , which is an equilibrium solution for the system	
$(a_{16})^{(2)}G_{17} - [(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})]G_{16} = 0$	443
$(a_{17})^{(2)}G_{16} - [(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})]G_{17} = 0$	444
$(a_{18})^{(2)}G_{17} - [(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})]G_{18} = 0$	445
$(b_{16})^{(2)}T_{17} - [(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}(G_{19})\ ]T_{16} = 0$	446
$(b_{17})^{(2)}T_{16} - [(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}(G_{19})\ ]T_{17} = 0$	447
$(b_{18})^{(2)}T_{17} - [(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}(G_{19})\ ]T_{18} = 0$	448
has a unique positive solution , which is an equilibrium solution	
$(a_{20})^{(3)}G_{21} - [(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21})]G_{20} = 0$	449
$(a_{21})^{(3)}G_{20} - [(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21})]G_{21} = 0$	450
$(a_{22})^{(3)}G_{21} - [(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21})]G_{22} = 0$	451
$(b_{20})^{(3)}T_{21} - [(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23})\ ]T_{20} = 0$	452
$(b_{21})^{(3)}T_{20} - [(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23})\ ]T_{21} = 0$	453
$(b_{22})^{(3)}T_{21} - [(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23})\ ]T_{22} = 0$	454
has a unique positive solution , which is an equilibrium solution	
$(a_{24})^{(4)}G_{25} - [(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25})]G_{24} = 0$	455
$(a_{25})^{(4)}G_{24} - [(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25})]G_{25} = 0$	456
$(a_{26})^{(4)}G_{25} - [(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25})]G_{26} = 0$	457

$(b_{24})^{(4)}T_{25} - [(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}\big((G_{27})\big)\,]T_{24} = 0$	458
$(b_{25})^{(4)}T_{24} - [(b_{25}^{'})^{(4)} - (b_{25}^{''})^{(4)}\big((G_{27})\big)\,]T_{25} = 0$	459
$(b_{26})^{(4)}T_{25} - [(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}\big((G_{27})\big)\,]T_{26} = 0$	460
has a unique positive solution , which is an equilibrium solution	
$(a_{28})^{(5)}G_{29} - \big[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29})\big]G_{28} = 0$	461
$(a_{29})^{(5)}G_{28} - \big[(a_{29}^{'})^{(5)} + (a_{29}^{''})^{(5)}(T_{29})\big]G_{29} = 0$	462
$(a_{30})^{(5)}G_{29} - \big[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29})\big]G_{30} = 0$	463
$(b_{28})^{(5)}T_{29} - [(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}(G_{31})\,]T_{28} = 0$	464
$(b_{29})^{(5)}T_{28} - [(b_{29}^{'})^{(5)} - (b_{29}^{''})^{(5)}(G_{31})\,]T_{29} = 0$	465
$(b_{30})^{(5)}T_{29} - [(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}(G_{31})\,]T_{30} = 0$	466
has a unique positive solution , which is an equilibrium solution	
$(a_{32})^{(6)}G_{33} - \big[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33})\big]G_{32} = 0$	467
$(a_{33})^{(6)}G_{32} - \big[(a_{33}^{'})^{(6)} + (a_{33}^{''})^{(6)}(T_{33})\big]G_{33} = 0$	468
$(a_{34})^{(6)}G_{33} - \big[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33})\big]G_{34} = 0$	469
$(b_{32})^{(6)}T_{33} - [(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}(G_{35})\,]T_{32} = 0$	470
$(b_{33})^{(6)}T_{32} - [(b_{33}^{'})^{(6)} - (b_{33}^{''})^{(6)}(G_{35})\,]T_{33} = 0$	471
$(b_{34})^{(6)}T_{33} - [(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}(G_{35})\,]T_{34} = 0$	472
has a unique positive solution , which is an equilibrium solution	
$(a_{36})^{(7)}G_{37} - \big[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\big]G_{36} = 0$	473
$(a_{37})^{(7)}G_{36} - \big[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\big]G_{37} = 0$	474

$(a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37})\right]G_{38} = 0$	475
$(b_{36})^{(7)}T_{37} - [(b'_{36})^{(7)} - (b''_{36})^{(7)}(G_{39})]T_{36} = 0$	476
$(b_{37})^{(7)}T_{36} - [(b'_{37})^{(7)} - (b''_{37})^{(7)}(G_{39})\ ]T_{37} = 0$	477
$(b_{38})^{(7)}T_{37} - [(b'_{38})^{(7)} - (b''_{38})^{(7)}(G_{39})\ ]T_{38} = 0$	478
$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0$	479
$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0$	480
$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0$	481
$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0$	482
$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0$	483
$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0$	484
$(a_{44})^{(9)}G_{45} - \left[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T_{45})\right]G_{44} = 0$	484 A
$(a_{45})^{(9)}G_{44} - \left[(a'_{45})^{(9)} + (a''_{45})^{(9)}(T_{45})\right]G_{45} = 0$	
$(a_{46})^{(9)}G_{45} - \left[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T_{45})\right]G_{46} = 0$	
$(b_{44})^{(9)}T_{45} - [(b'_{44})^{(9)} - (b''_{44})^{(9)}(G_{47})\ ]T_{44} = 0$	
$(b_{45})^{(9)}T_{44} - [(b'_{45})^{(9)} - (b''_{45})^{(9)}(G_{47})\ ]T_{45} = 0$	
$(b_{46})^{(9)}T_{45} - [(b'_{46})^{(9)} - (b''_{46})^{(9)}(G_{47})\ ]T_{46} = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{13}, G_{14} if $F(T) = (a'_{13})^{(1)}(a'_{14})^{(1)} - (a_{13})^{(1)}(a_{14})^{(1)} + (a'_{13})^{(1)}(a''_{14})^{(1)}(T_{14}) + (a'_{14})^{(1)}(a''_{13})^{(1)}(T_{14}) +$ $(a''_{13})^{(1)}(T_{14})(a''_{14})^{(1)}(T_{14}) = 0$	485
Proof: (ll) Indeed the first two equations have a nontrivial solution G_{16}, G_{17} if $\mathrm{F}(T_{19}) = (a'_{16})^{(2)}(a'_{17})^{(2)} - (a_{16})^{(2)}(a_{17})^{(2)} + (a'_{16})^{(2)}(a''_{17})^{(2)}(T_{17}) + (a'_{17})^{(2)}(a''_{16})^{(2)}(T_{17}) +$	486

$(a_{16}^{''})^{(2)}(T_{17})(a_{17}^{''})^{(2)}(T_{17}) = 0$	
Proof: (a) Indeed the first two equations have a nontrivial solution G_{20}, G_{21} if $F(T_{23}) = (a_{20}^{'})^{(3)}(a_{21}^{'})^{(3)} - (a_{20})^{(3)}(a_{21})^{(3)} + (a_{20}^{'})^{(3)}(a_{21}^{''})^{(3)}(T_{21}) + (a_{21}^{'})^{(3)}(a_{20}^{''})^{(3)}(T_{21}) + (a_{20}^{''})^{(3)}(T_{21})(a_{21}^{''})^{(3)}(T_{21}) = 0$	487
Proof: (a) Indeed the first two equations have a nontrivial solution G_{24}, G_{25} if $F(T_{27}) = (a_{24}^{'})^{(4)}(a_{25}^{'})^{(4)} - (a_{24})^{(4)}(a_{25})^{(4)} + (a_{24}^{'})^{(4)}(a_{25}^{''})^{(4)}(T_{25}) + (a_{25}^{'})^{(4)}(a_{24}^{''})^{(4)}(T_{25}) + (a_{24}^{''})^{(4)}(T_{25})(a_{25}^{''})^{(4)}(T_{25}) = 0$	488
Proof: (a) Indeed the first two equations have a nontrivial solution G_{28}, G_{29} if $F(T_{31}) = (a_{28}^{'})^{(5)}(a_{29}^{'})^{(5)} - (a_{28})^{(5)}(a_{29})^{(5)} + (a_{28}^{'})^{(5)}(a_{29}^{''})^{(5)}(T_{29}) + (a_{29}^{'})^{(5)}(a_{28}^{''})^{(5)}(T_{29}) + (a_{28}^{''})^{(5)}(T_{29})(a_{29}^{''})^{(5)}(T_{29}) = 0$	489
Proof: (a) Indeed the first two equations have a nontrivial solution G_{32}, G_{33} if $F(T_{35}) = (a_{32}^{'})^{(6)}(a_{33}^{'})^{(6)} - (a_{32})^{(6)}(a_{33})^{(6)} + (a_{32}^{'})^{(6)}(a_{33}^{''})^{(6)}(T_{33}) + (a_{33}^{'})^{(6)}(a_{32}^{''})^{(6)}(T_{33}) + (a_{32}^{''})^{(6)}(T_{33})(a_{33}^{''})^{(6)}(T_{33}) = 0$	490
Proof: (a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if $F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$	491
Proof: (a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if $F(T_{43}) = (a_{40}^{'})^{(8)}(a_{41}^{'})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a_{40}^{'})^{(8)}(a_{41}^{''})^{(8)}(T_{41}) + (a_{41}^{'})^{(8)}(a_{40}^{''})^{(8)}(T_{41}) + (a_{40}^{''})^{(8)}(T_{41})(a_{41}^{''})^{(8)}(T_{41}) = 0$	492
Proof: (a) Indeed the first two equations have a nontrivial solution G_{44}, G_{45} if $F(T_{47}) = (a_{44}^{'})^{(9)}(a_{45}^{'})^{(9)} - (a_{44})^{(9)}(a_{45})^{(9)} + (a_{44}^{'})^{(9)}(a_{45}^{''})^{(9)}(T_{45}) + (a_{45}^{'})^{(9)}(a_{44}^{''})^{(9)}(T_{45}) + (a_{44}^{''})^{(9)}(T_{45})(a_{45}^{''})^{(9)}(T_{45}) = 0$	492 A

Definition and uniqueness of T_{14}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{14})$ being increasing, it follows that there exists a unique T_{14}^* for which $f(T_{14}^*) = 0$. With this value , we obtain from the three first equations $G_{13} = \frac{(a_{13})^{(1)}G_{14}}{[(a_{13}')^{(1)}+(a_{13}'')^{(1)}(T_{14}^*)]}$, $G_{15} = \frac{(a_{15})^{(1)}G_{14}}{[(a_{15}')^{(1)}+(a_{15}'')^{(1)}(T_{14}^*)]}$	493
Definition and uniqueness of T_{17}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(2)}(T_{17})$ being increasing, it follows that there exists a unique T_{17}^* for which $f(T_{17}^*) = 0$. With this value , we obtain from the three first equations	494
$G_{16} = \frac{(a_{16})^{(2)}G_{17}}{[(a_{16}')^{(2)}+(a_{16}'')^{(2)}(T_{17}^*)]}$, $G_{18} = \frac{(a_{18})^{(2)}G_{17}}{[(a_{18}')^{(2)}+(a_{18}'')^{(2)}(T_{17}^*)]}$	495
Definition and uniqueness of T_{21}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^* for which $f(T_{21}^*) = 0$. With this value , we obtain from the three first equations $G_{20} = \frac{(a_{20})^{(3)}G_{21}}{[(a_{20}')^{(3)}+(a_{20}'')^{(3)}(T_{21}^*)]}$, $G_{22} = \frac{(a_{22})^{(3)}G_{21}}{[(a_{22}')^{(3)}+(a_{22}'')^{(3)}(T_{21}^*)]}$	496
Definition and uniqueness of T_{25}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^* for which $f(T_{25}^*) = 0$. With this value , we obtain from the three first equations $G_{24} = \frac{(a_{24})^{(4)}G_{25}}{[(a_{24}')^{(4)}+(a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26} = \frac{(a_{26})^{(4)}G_{25}}{[(a_{26}')^{(4)}+(a_{26}'')^{(4)}(T_{25}^*)]}$	497
Definition and uniqueness of T_{29}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^* for which $f(T_{29}^*) = 0$. With this value , we obtain from the three first equations $G_{28} = \frac{(a_{28})^{(5)}G_{29}}{[(a_{28}')^{(5)}+(a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30} = \frac{(a_{30})^{(5)}G_{29}}{[(a_{30}')^{(5)}+(a_{30}'')^{(5)}(T_{29}^*)]}$	498
Definition and uniqueness of T_{33}^* :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i'')^{(6)}(T_{33})$ being increasing, it follows that there exists a unique T_{33}^* for which $f(T_{33}^*) = 0$. With this value , we obtain from the three first equations	499

$G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T^*_{33})]}$, $G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T^*_{33})]}$	
<u>Definition and uniqueness of</u> T^*_{37} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T^*_{37} for which $f(T^*_{37}) = 0$. With this value , we obtain from the three first equations $G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T^*_{37})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T^*_{37})]}$	500
<u>Definition and uniqueness of</u> T^*_{41} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T^*_{41} for which $f(T^*_{41}) = 0$. With this value , we obtain from the three first equations $G_{40} = \frac{(a_{40})^{(8)} G_{41}}{[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T^*_{41})]}$, $G_{42} = \frac{(a_{42})^{(8)} G_{41}}{[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T^*_{41})]}$	501
<u>Definition and uniqueness of</u> T^*_{45} :- After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(9)}(T_{45})$ being increasing, it follows that there exists a unique T^*_{45} for which $f(T^*_{45}) = 0$. With this value , we obtain from the three first equations $G_{44} = \frac{(a_{44})^{(9)} G_{45}}{[(a'_{44})^{(9)} + (a''_{44})^{(9)}(T^*_{45})]}$, $G_{46} = \frac{(a_{46})^{(9)} G_{45}}{[(a'_{46})^{(9)} + (a''_{46})^{(9)}(T^*_{45})]}$	501 A
By the same argument, the equations admit solutions G_{13}, G_{14} if $\varphi(G) = (b'_{13})^{(1)}(b'_{14})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$ $\left[(b'_{13})^{(1)}(b''_{14})^{(1)}(G) + (b'_{14})^{(1)}(b''_{13})^{(1)}(G)\right] + (b''_{13})^{(1)}(G)(b''_{14})^{(1)}(G) = 0$ Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that there exists a unique G^*_{14} such that $\varphi(G^*) = 0$	502
By the same argument, the equations admit solutions G_{16}, G_{17} if $\varphi(G_{19}) = (b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$ $\left[(b'_{16})^{(2)}(b''_{17})^{(2)}(G_{19}) + (b'_{17})^{(2)}(b''_{16})^{(2)}(G_{19})\right] + (b''_{16})^{(2)}(G_{19})(b''_{17})^{(2)}(G_{19}) = 0$	503
Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0 , \varphi(\infty) < 0$ it follows that	504

there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*})=0$	
By the same argument, the equations admit solutions G_{20}, G_{21} if $\varphi(G_{23})=(b_{20}')^{(3)}(b_{21}')^{(3)}-(b_{20})^{(3)}(b_{21})^{(3)}-$ $\left[(b_{20}')^{(3)}(b_{21}'')^{(3)}(G_{23})+(b_{21}')^{(3)}(b_{20}'')^{(3)}(G_{23})\right]+(b_{20}'')^{(3)}(G_{23})(b_{21}'')^{(3)}(G_{23})=0$ Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*})=0$	505
By the same argument, the equations admit solutions G_{24}, G_{25} if $\varphi(G_{27})=(b_{24}')^{(4)}(b_{25}')^{(4)}-(b_{24})^{(4)}(b_{25})^{(4)}-$ $\left[(b_{24}')^{(4)}(b_{25}'')^{(4)}(G_{27})+(b_{25}')^{(4)}(b_{24}'')^{(4)}(G_{27})\right]+(b_{24}'')^{(4)}(G_{27})(b_{25}'')^{(4)}(G_{27})=0$ Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*})=0$	506
By the same argument, the equations admit solutions G_{28}, G_{29} if $\varphi(G_{31})=(b_{28}')^{(5)}(b_{29}')^{(5)}-(b_{28})^{(5)}(b_{29})^{(5)}-$ $\left[(b_{28}')^{(5)}(b_{29}'')^{(5)}(G_{31})+(b_{29}')^{(5)}(b_{28}'')^{(5)}(G_{31})\right]+(b_{28}'')^{(5)}(G_{31})(b_{29}'')^{(5)}(G_{31})=0$ Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*})=0$	507
By the same argument, the equations admit solutions G_{32}, G_{33} if $\varphi(G_{35})=(b_{32}')^{(6)}(b_{33}')^{(6)}-(b_{32})^{(6)}(b_{33})^{(6)}-$ $\left[(b_{32}')^{(6)}(b_{33}'')^{(6)}(G_{35})+(b_{33}')^{(6)}(b_{32}'')^{(6)}(G_{35})\right]+(b_{32}'')^{(6)}(G_{35})(b_{33}'')^{(6)}(G_{35})=0$ Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G_{35}{}^{*})=0$	508
By the same argument, the equations admit solutions G_{36}, G_{37} if $\varphi(G_{39})=(b_{36}')^{(7)}(b_{37}')^{(7)}-(b_{36})^{(7)}(b_{37})^{(7)}-$ $\left[(b_{36}')^{(7)}(b_{37}'')^{(7)}(G_{39})+(b_{37}')^{(7)}(b_{36}'')^{(7)}(G_{39})\right]+(b_{36}'')^{(7)}(G_{39})(b_{37}'')^{(7)}(G_{39})=0$ Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0)>0, \varphi(\infty)<0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G_{39}{}^{*})=0$	509
By the same argument, the equations admit solutions G_{40}, G_{41} if	510

$\varphi(G_{43}) = (b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{40})^{(8)}(b_{41})^{(8)} -$ $\left[(b'_{40})^{(8)}(b''_{41})^{(8)}(G_{43}) + (b'_{41})^{(8)}(b''_{40})^{(8)}(G_{43})\right]+(b''_{40})^{(8)}(G_{43})(b''_{41})^{(8)}(G_{43}) = 0$ Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{41} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{41} such that $\varphi(G_{43}{}^*) = 0$	
By the same argument, the equations 92,93 admit solutions G_{44}, G_{45} if $\varphi(G_{47}) = (b'_{44})^{(9)}(b'_{45})^{(9)} - (b_{44})^{(9)}(b_{45})^{(9)} -$ $\left[(b'_{44})^{(9)}(b''_{45})^{(9)}(G_{47}) + (b'_{45})^{(9)}(b''_{44})^{(9)}(G_{47})\right]+(b''_{44})^{(9)}(G_{47})(b''_{45})^{(9)}(G_{47}) = 0$ Where in $(G_{47})(G_{44}, G_{45}, G_{46}), G_{44}, G_{46}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{45} such that $\varphi((G_{47})^*) = 0$	
Finally we obtain the unique solution G^*_{14} given by $\varphi(G^*) = 0$, T^*_{14} given by $f(T^*_{14}) = 0$ and $G^*_{13} = \frac{(a_{13})^{(1)}G^*_{14}}{[(a'_{13})^{(1)}+(a''_{13})^{(1)}(T^*_{14})]}$, $G^*_{15} = \frac{(a_{15})^{(1)}G^*_{14}}{[(a'_{15})^{(1)}+(a''_{15})^{(1)}(T^*_{14})]}$ $T^*_{13} = \frac{(b_{13})^{(1)}T^*_{14}}{[(b'_{13})^{(1)}-(b''_{13})^{(1)}(G^*)]}$, $T^*_{15} = \frac{(b_{15})^{(1)}T^*_{14}}{[(b'_{15})^{(1)}-(b''_{15})^{(1)}(G^*)]}$ Obviously, these values represent an equilibrium solution	511
Finally we obtain the unique solution	
G^*_{17} given by $\varphi((G_{19})^*) = 0$, T^*_{17} given by $f(T^*_{17}) = 0$ and	512
$G^*_{16} = \frac{(a_{16})^{(2)}G^*_{17}}{[(a'_{16})^{(2)}+(a''_{16})^{(2)}(T^*_{17})]}$, $G^*_{18} = \frac{(a_{18})^{(2)}G^*_{17}}{[(a'_{18})^{(2)}+(a''_{18})^{(2)}(T^*_{17})]}$	513
$T^*_{16} = \frac{(b_{16})^{(2)}T^*_{17}}{[(b'_{16})^{(2)}-(b''_{16})^{(2)}((G_{19})^*)]}$, $T^*_{18} = \frac{(b_{18})^{(2)}T^*_{17}}{[(b'_{18})^{(2)}-(b''_{18})^{(2)}((G_{19})^*)]}$	514
Obviously, these values represent an equilibrium solution	
Finally we obtain the unique solution G^*_{21} given by $\varphi((G_{23})^*) = 0$, T^*_{21} given by $f(T^*_{21}) = 0$ and $G^*_{20} = \frac{(a_{20})^{(3)}G^*_{21}}{[(a'_{20})^{(3)}+(a''_{20})^{(3)}(T^*_{21})]}$, $G^*_{22} = \frac{(a_{22})^{(3)}G^*_{21}}{[(a'_{22})^{(3)}+(a''_{22})^{(3)}(T^*_{21})]}$ $T^*_{20} = \frac{(b_{20})^{(3)}T^*_{21}}{[(b'_{20})^{(3)}-(b''_{20})^{(3)}(G_{23}{}^*)]}$, $T^*_{22} = \frac{(b_{22})^{(3)}T^*_{21}}{[(b'_{22})^{(3)}-(b''_{22})^{(3)}(G_{23}{}^*)]}$ Obviously, these values represent an equilibrium solution of global equations	515

Finally we obtain the unique solution G_{25}^* given by $\varphi(G_{27}) = 0$, T_{25}^* given by $f(T_{25}^*) = 0$ and $G_{24}^* = \frac{(a_{24})^{(4)} G_{25}^*}{[(a_{24}')^{(4)} + (a_{24}'')^{(4)}(T_{25}^*)]}$, $G_{26}^* = \frac{(a_{26})^{(4)} G_{25}^*}{[(a_{26}')^{(4)} + (a_{26}'')^{(4)}(T_{25}^*)]}$	516
$T_{24}^* = \frac{(b_{24})^{(4)} T_{25}^*}{[(b_{24}')^{(4)} - (b_{24}'')^{(4)}((G_{27})^*)]}$, $T_{26}^* = \frac{(b_{26})^{(4)} T_{25}^*}{[(b_{26}')^{(4)} - (b_{26}'')^{(4)}((G_{27})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	517
Finally we obtain the unique solution G_{29}^* given by $\varphi((G_{31})^*) = 0$, T_{29}^* given by $f(T_{29}^*) = 0$ and $G_{28}^* = \frac{(a_{28})^{(5)} G_{29}^*}{[(a_{28}')^{(5)} + (a_{28}'')^{(5)}(T_{29}^*)]}$, $G_{30}^* = \frac{(a_{30})^{(5)} G_{29}^*}{[(a_{30}')^{(5)} + (a_{30}'')^{(5)}(T_{29}^*)]}$	518
$T_{28}^* = \frac{(b_{28})^{(5)} T_{29}^*}{[(b_{28}')^{(5)} - (b_{28}'')^{(5)}((G_{31})^*)]}$, $T_{30}^* = \frac{(b_{30})^{(5)} T_{29}^*}{[(b_{30}')^{(5)} - (b_{30}'')^{(5)}((G_{31})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	519
Finally we obtain the unique solution G_{33}^* given by $\varphi((G_{35})^*) = 0$, T_{33}^* given by $f(T_{33}^*) = 0$ and $G_{32}^* = \frac{(a_{32})^{(6)} G_{33}^*}{[(a_{32}')^{(6)} + (a_{32}'')^{(6)}(T_{33}^*)]}$, $G_{34}^* = \frac{(a_{34})^{(6)} G_{33}^*}{[(a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}^*)]}$	520
$T_{32}^* = \frac{(b_{32})^{(6)} T_{33}^*}{[(b_{32}')^{(6)} - (b_{32}'')^{(6)}((G_{35})^*)]}$, $T_{34}^* = \frac{(b_{34})^{(6)} T_{33}^*}{[(b_{34}')^{(6)} - (b_{34}'')^{(6)}((G_{35})^*)]}$ Obviously, these values represent an equilibrium solution of global equations	521
Finally we obtain the unique solution G_{37}^* given by $\varphi((G_{39})^*) = 0$, T_{37}^* given by $f(T_{37}^*) = 0$ and $G_{36}^* = \frac{(a_{36})^{(7)} G_{37}^*}{[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37}^*)]}$, $G_{38}^* = \frac{(a_{38})^{(7)} G_{37}^*}{[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37}^*)]}$ $T_{36}^* = \frac{(b_{36})^{(7)} T_{37}^*}{[(b_{36}')^{(7)} - (b_{36}'')^{(7)}((G_{39})^*)]}$, $T_{38}^* = \frac{(b_{38})^{(7)} T_{37}^*}{[(b_{38}')^{(7)} - (b_{38}'')^{(7)}((G_{39})^*)]}$	522
Finally we obtain the unique solution G_{41}^* given by $\varphi((G_{43})^*) = 0$, T_{41}^* given by $f(T_{41}^*) = 0$ and $G_{40}^* = \frac{(a_{40})^{(8)} G_{41}^*}{[(a_{40}')^{(8)} + (a_{40}'')^{(8)}(T_{41}^*)]}$, $G_{42}^* = \frac{(a_{42})^{(8)} G_{41}^*}{[(a_{42}')^{(8)} + (a_{42}'')^{(8)}(T_{41}^*)]}$	523

$T_{40}^* = \frac{(b_{40})^{(8)} T_{41}^*}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^*)]}$, $T_{42}^* = \frac{(b_{42})^{(8)} T_{41}^*}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^*)]}$	
Finally we obtain the unique solution of 89 to 99 G_{45}^* given by $\varphi((G_{47})^*) = 0$, T_{45}^* given by $f(T_{45}^*) = 0$ and $G_{44}^* = \frac{(a_{44})^{(9)} G_{45}^*}{[(a_{44}^{'})^{(9)} + (a_{44}^{''})^{(9)}(T_{45}^*)]}$, $G_{46}^* = \frac{(a_{46})^{(9)} G_{45}^*}{[(a_{46}^{'})^{(9)} + (a_{46}^{''})^{(9)}(T_{45}^*)]}$ $T_{44}^* = \frac{(b_{44})^{(9)} T_{45}^*}{[(b_{44}^{'})^{(9)} - (b_{44}^{''})^{(9)}((G_{47})^*)]}$, $T_{46}^* = \frac{(b_{46})^{(9)} T_{45}^*}{[(b_{46}^{'})^{(9)} - (b_{46}^{''})^{(9)}((G_{47})^*)]}$	523 A
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ *and* $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:**_Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i$, $T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^*) = (q_{14})^{(1)}$, $\frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^*) = s_{ij}$	524
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{13}}{dt} = -((a_{13}^{'})^{(1)} + (p_{13})^{(1)})\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^* \mathbb{T}_{14}$	525
$\frac{d\mathbb{G}_{14}}{dt} = -((a_{14}^{'})^{(1)} + (p_{14})^{(1)})\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^* \mathbb{T}_{14}$	526
$\frac{d\mathbb{G}_{15}}{dt} = -((a_{15}^{'})^{(1)} + (p_{15})^{(1)})\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^* \mathbb{T}_{14}$	527
$\frac{d\mathbb{T}_{13}}{dt} = -((b_{13}^{'})^{(1)} - (r_{13})^{(1)})\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(13)(j)} T_{13}^* \mathbb{G}_j)$	528
$\frac{d\mathbb{T}_{14}}{dt} = -((b_{14}^{'})^{(1)} - (r_{14})^{(1)})\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}(s_{(14)(j)} T_{14}^* \mathbb{G}_j)$	529
$\frac{d\mathbb{T}_{15}}{dt} = -((b_{15}^{'})^{(1)} - (r_{15})^{(1)})\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}(s_{(15)(j)} T_{15}^* \mathbb{G}_j)$	530
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions	531

$(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable	
Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:-	
$G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$	532
$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^*) = (q_{17})^{(2)} \quad , \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^*) = s_{ij}$	533
taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)}G_{16}^*\mathbb{T}_{17}$	534
$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)}G_{17}^*\mathbb{T}_{17}$	535
$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)}G_{18}^*\mathbb{T}_{17}$	536
$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)}T_{16}^*\mathbb{G}_j\right)$	537
$\frac{d\mathbb{T}_{17}}{dt} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}T_{17}^*\mathbb{G}_j\right)$	538
$\frac{d\mathbb{T}_{18}}{dt} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}T_{18}^*\mathbb{G}_j\right)$	539
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}$ *and* $(b_i^{''})^{(3)}$ Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote **Definition of** $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial (b_i^{''})^{(3)}}{\partial G_j}((G_{23})^*) = s_{ij}$	540
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^*\mathbb{T}_{21}$	541
$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^*\mathbb{T}_{21}$	542
$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^*\mathbb{T}_{21}$	543
$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^*\mathbb{G}_j\right)$	544

$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}')^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^*\mathbb{G}_j\right)$	545
$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}')^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^*\mathbb{G}_j\right)$	546
ASYMPTOTIC STABILITY ANALYSIS **Theorem 4:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(4)}$ *and* $(b_i'')^{(4)}$ Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	547
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{25}'')^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial (b_i'')^{(4)}}{\partial G_j}((G_{27})^* \ ) = s_{ij}$	548
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}')^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^*\mathbb{T}_{25}$	549
$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}')^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^*\mathbb{T}_{25}$	550
$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}')^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^*\mathbb{T}_{25}$	551
$\frac{d\mathbb{T}_{24}}{dt} = -\left((b_{24}')^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T_{24}^*\mathbb{G}_j\right)$	552
$\frac{d\mathbb{T}_{25}}{dt} = -\left((b_{25}')^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T_{25}^*\mathbb{G}_j\right)$	553
$\frac{d\mathbb{T}_{26}}{dt} = -\left((b_{26}')^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T_{26}^*\mathbb{G}_j\right)$	554
ASYMPTOTIC STABILITY ANALYSIS **Theorem 5:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(5)}$ *and* $(b_i'')^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	555
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{29}'')^{(5)}}{\partial T_{29}}(T_{29}^*) = (q_{29})^{(5)} \quad , \frac{\partial (b_i'')^{(5)}}{\partial G_j}(\ (G_{31})^* \ ) = s_{ij}$	556
Then taking into account equations and neglecting the terms of power 2, we obtain	

$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G^*_{28}\mathbb{T}_{29}$	557
$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G^*_{29}\mathbb{T}_{29}$	558
$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G^*_{30}\mathbb{T}_{29}$	559
$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T^*_{28}\mathbb{G}_j\right)$	560
$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T^*_{29}\mathbb{G}_j\right)$	561
$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T^*_{30}\mathbb{G}_j\right)$	562
ASYMPTOTIC STABILITY ANALYSIS **Theorem 6:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(6)}$ *and* $(b''_i)^{(6)}$ Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	563
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a''_{33})^{(6)}}{\partial T_{33}}(T^*_{33}) = (q_{33})^{(6)} \quad , \frac{\partial (b''_i)^{(6)}}{\partial G_j}(\,(G_{35})^*\,) = s_{ij}$	564
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G^*_{32}\mathbb{T}_{33}$	565
$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G^*_{33}\mathbb{T}_{33}$	566
$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G^*_{34}\mathbb{T}_{33}$	567
$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T^*_{32}\mathbb{G}_j\right)$	568
$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T^*_{33}\mathbb{G}_j\right)$	569
$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T^*_{34}\mathbb{G}_j\right)$	570
ASYMPTOTIC STABILITY ANALYSIS **Theorem 7:** If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ *and* $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	571

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{37}'')^{(7)}}{\partial T_{37}} (T_{37}^*) = (q_{37})^{(7)} \;,\; \frac{\partial (b_i'')^{(7)}}{\partial G_j} ((G_{39})^{**}) = s_{ij}$	572
Then taking into account equations and neglecting the terms of power 2, we obtain from	
$\frac{d\mathbb{G}_{36}}{dt} = -\left((a_{36}')^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G_{36}^* \mathbb{T}_{37}$	573
$\frac{d\mathbb{G}_{37}}{dt} = -\left((a_{37}')^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G_{37}^* \mathbb{T}_{37}$	574
$\frac{d\mathbb{G}_{38}}{dt} = -\left((a_{38}')^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G_{38}^* \mathbb{T}_{37}$	575
$\frac{d\mathbb{T}_{36}}{dt} = -\left((b_{36}')^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T_{36}^* \mathbb{G}_j\right)$	576
$\frac{d\mathbb{T}_{37}}{dt} = -\left((b_{37}')^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T_{37}^* \mathbb{G}_j\right)$	578
$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}')^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T_{38}^* \mathbb{G}_j\right)$	579
Obviously, these values represent an equilibrium solution **ASYMPTOTIC STABILITY ANALYSIS** **Theorem 8:** If the conditions of the previous theorem are satisfied and if the functions $(a_i'')^{(8)}$ *and* $(b_i'')^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. Proof: Denote	
Definition of $\mathbb{G}_i, \mathbb{T}_i$:- $G_i = G_i^* + \mathbb{G}_i \quad , T_i = T_i^* + \mathbb{T}_i$ $\frac{\partial (a_{41}'')^{(8)}}{\partial T_{41}} (T_{41}^*) = (q_{41})^{(8)} \;,\; \frac{\partial (b_i'')^{(8)}}{\partial G_j} ((G_{43})^{*}) = s_{ij}$	580
Then taking into account equations and neglecting the terms of power 2, we obtain	
$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}')^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)} G_{40}^* \mathbb{T}_{41}$	581
$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}')^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)} G_{41}^* \mathbb{T}_{41}$	582
$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}')^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)} G_{42}^* \mathbb{T}_{41}$	583

$\frac{d\mathbb{T}_{40}}{dt}=-\left((b_{40}^{'})^{(8)}-(r_{40})^{(8)}\right)\mathbb{T}_{40}+(b_{40})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_{j}\right)$	584
$\frac{d\mathbb{T}_{41}}{dt}=-\left((b_{41}^{'})^{(8)}-(r_{41})^{(8)}\right)\mathbb{T}_{41}+(b_{41})^{(8)}\mathbb{T}_{40}+\sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_{j}\right)$	585
$\frac{d\mathbb{T}_{42}}{dt}=-\left((b_{42}^{'})^{(8)}-(r_{42})^{(8)}\right)\mathbb{T}_{42}+(b_{42})^{(8)}\mathbb{T}_{41}+\sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_{j}\right)$	586
ASYMPTOTIC STABILITY ANALYSIS **Theorem 9:** If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(9)}$ *and* $(b_i^{''})^{(9)}$ Belong to $C^{(9)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. **Proof:** Denote	586 A
Definition of $\mathbb{G}_i,\mathbb{T}_i$:- $G_i=G_i^{*}+\mathbb{G}_i \quad ,T_i=T_i^{*}+\mathbb{T}_i$ $\frac{\partial(a_{45}^{''})^{(9)}}{\partial T_{45}}(T_{45}^{*})=(q_{45})^{(9)} \quad , \frac{\partial(b_i^{''})^{(9)}}{\partial G_j}((G_{47})^{*})=s_{ij}$	
Then taking into account equations 89 to 99 and neglecting the terms of power 2, we obtain from 99 to 44	
$\frac{d\mathbb{G}_{44}}{dt}=-\left((a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\mathbb{G}_{44}+(a_{44})^{(9)}\mathbb{G}_{45}-(q_{44})^{(9)}G_{44}^{*}\mathbb{T}_{45}$	586 B
$\frac{d\mathbb{G}_{45}}{dt}=-\left((a_{45}^{'})^{(9)}+(p_{45})^{(9)}\right)\mathbb{G}_{45}+(a_{45})^{(9)}\mathbb{G}_{44}-(q_{45})^{(9)}G_{45}^{*}\mathbb{T}_{45}$	586 C
$\frac{d\mathbb{G}_{46}}{dt}=-\left((a_{46}^{'})^{(9)}+(p_{46})^{(9)}\right)\mathbb{G}_{46}+(a_{46})^{(9)}\mathbb{G}_{45}-(q_{46})^{(9)}G_{46}^{*}\mathbb{T}_{45}$	586 D
$\frac{d\mathbb{T}_{44}}{dt}=-\left((b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)\mathbb{T}_{44}+(b_{44})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(44)(j)}T_{44}^{*}\mathbb{G}_{j}\right)$	586 E
$\frac{d\mathbb{T}_{45}}{dt}=-\left((b_{45}^{'})^{(9)}-(r_{45})^{(9)}\right)\mathbb{T}_{45}+(b_{45})^{(9)}\mathbb{T}_{44}+\sum_{j=44}^{46}\left(s_{(45)(j)}T_{45}^{*}\mathbb{G}_{j}\right)$	586 F
$\frac{d\mathbb{T}_{46}}{dt}=-\left((b_{46}^{'})^{(9)}-(r_{46})^{(9)}\right)\mathbb{T}_{46}+(b_{46})^{(9)}\mathbb{T}_{45}+\sum_{j=44}^{46}\left(s_{(46)(j)}T_{46}^{*}\mathbb{G}_{j}\right)$	586 G
The characteristic equation of this system is	587
$\left((\lambda)^{(1)}+(b_{15}^{'})^{(1)}-(r_{15})^{(1)}\right)\{\left((\lambda)^{(1)}+(a_{15}^{'})^{(1)}+(p_{15})^{(1)}\right)$ $\left[\left(\left((\lambda)^{(1)}+(a_{13}^{'})^{(1)}+(p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*}+(a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$ $+\left(\left((\lambda)^{(1)}+(a_{14}^{'})^{(1)}+(p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*}+(a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$ $\left(\left((\lambda)^{(1)}+(b_{13}^{'})^{(1)}-(r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*}+(b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$	

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left((b_{13}')^{(1)} + (b_{14}')^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right) (\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2 + \left((a_{13}')^{(1)} + (a_{14}')^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right) (\lambda)^{(1)}\right) (q_{15})^{(1)} G_{15}$$

$$+((\lambda)^{(1)} + (a_{13}')^{(1)} + (p_{13})^{(1)}) \left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^* + (a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$$

$$\left(((\lambda)^{(1)} + (b_{13}')^{(1)} - (r_{13})^{(1)})s_{(14),(15)}T_{14}^* + (b_{14})^{(1)}s_{(13),(15)}T_{13}^*\right)\} = 0$$

$$+$$

$$((\lambda)^{(2)} + (b_{18}')^{(2)} - (r_{18})^{(2)})\{((\lambda)^{(2)} + (a_{18}')^{(2)} + (p_{18})^{(2)})$$

$$\left[\left(((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)})(q_{17})^{(2)}\mathrm{G}_{17}^* + (a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)\right]$$

$$\left(((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)})s_{(17),(17)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^*\right)$$

$$+\left(((\lambda)^{(2)} + (a_{17}')^{(2)} + (p_{17})^{(2)})(q_{16})^{(2)}\mathrm{G}_{16}^* + (a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^*\right)$$

$$\left(((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)})s_{(17),(16)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^*\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$\left(\left((\lambda)^{(2)}\right)^2 + \left((b_{16}')^{(2)} + (b_{17}')^{(2)} - (r_{16})^{(2)} + (r_{17})^{(2)}\right) (\lambda)^{(2)}\right)$$

$$+\left(\left((\lambda)^{(2)}\right)^2 + \left((a_{16}')^{(2)} + (a_{17}')^{(2)} + (p_{16})^{(2)} + (p_{17})^{(2)}\right) (\lambda)^{(2)}\right) (q_{18})^{(2)} \mathrm{G}_{18}$$

$$+((\lambda)^{(2)} + (a_{16}')^{(2)} + (p_{16})^{(2)}) \left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^* + (a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)$$

$$\left(((\lambda)^{(2)} + (b_{16}')^{(2)} - (r_{16})^{(2)})s_{(17),(18)}\mathrm{T}_{17}^* + (b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^*\right)\} = 0$$

$$+$$

$$((\lambda)^{(3)} + (b_{22}')^{(3)} - (r_{22})^{(3)})\{((\lambda)^{(3)} + (a_{22}')^{(3)} + (p_{22})^{(3)})$$

$$\left[\left(((\lambda)^{(3)} + (a_{20}')^{(3)} + (p_{20})^{(3)})(q_{21})^{(3)}G_{21}^* + (a_{21})^{(3)}(q_{20})^{(3)}G_{20}^*\right)\right]$$

$$\left(((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)})s_{(21),(21)}T_{21}^* + (b_{21})^{(3)}s_{(20),(21)}T_{21}^*\right)$$

$$+\left(((\lambda)^{(3)} + (a_{21}')^{(3)} + (p_{21})^{(3)})(q_{20})^{(3)}G_{20}^* + (a_{20})^{(3)}(q_{21})^{(1)}G_{21}^*\right)$$

$$\left(((\lambda)^{(3)} + (b_{20}')^{(3)} - (r_{20})^{(3)})s_{(21),(20)}T_{21}^* + (b_{21})^{(3)}s_{(20),(20)}T_{20}^*\right)$$

$\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $\left(\left((\lambda)^{(3)}\right)^2 + \left((b_{20}^{'})^{(3)} + (b_{21}^{'})^{(3)} - (r_{20})^{(3)} + (r_{21})^{(3)}\right) (\lambda)^{(3)}\right)$ $+\left(\left((\lambda)^{(3)}\right)^2 + \left((a_{20}^{'})^{(3)} + (a_{21}^{'})^{(3)} + (p_{20})^{(3)} + (p_{21})^{(3)}\right) (\lambda)^{(3)}\right)(q_{22})^{(3)}G_{22}$ $+((\lambda)^{(3)} + (a_{20}^{'})^{(3)} + (p_{20})^{(3)})\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^{*} + (a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^{*}\right)$ $\left(\left((\lambda)^{(3)} + (b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^{*} + (b_{21})^{(3)}s_{(20),(22)}T_{20}^{*}\right)\} = 0$ +	
$\left((\lambda)^{(4)} + (b_{26}^{'})^{(4)} - (r_{26})^{(4)}\right)\{\left((\lambda)^{(4)} + (a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)$ $\left[\left(\left((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)\right]$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(25)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(25)}T_{25}^{*}\right)$ $+\left(\left((\lambda)^{(4)} + (a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)(q_{24})^{(4)}G_{24}^{*} + (a_{24})^{(4)}(q_{25})^{(4)}G_{25}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(24)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(24)}T_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $\left(\left((\lambda)^{(4)}\right)^2 + \left((b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (r_{24})^{(4)} + (r_{25})^{(4)}\right) (\lambda)^{(4)}\right)$ $+\left(\left((\lambda)^{(4)}\right)^2 + \left((a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} + (p_{24})^{(4)} + (p_{25})^{(4)}\right) (\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$ $+((\lambda)^{(4)} + (a_{24}^{'})^{(4)} + (p_{24})^{(4)})\left((a_{26})^{(4)}(q_{25})^{(4)}G_{25}^{*} + (a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G_{24}^{*}\right)$ $\left(\left((\lambda)^{(4)} + (b_{24}^{'})^{(4)} - (r_{24})^{(4)}\right)s_{(25),(26)}T_{25}^{*} + (b_{25})^{(4)}s_{(24),(26)}T_{24}^{*}\right)\} = 0$ +	
$\left((\lambda)^{(5)} + (b_{30}^{'})^{(5)} - (r_{30})^{(5)}\right)\{\left((\lambda)^{(5)} + (a_{30}^{'})^{(5)} + (p_{30})^{(5)}\right)$ $\left[\left(\left((\lambda)^{(5)} + (a_{28}^{'})^{(5)} + (p_{28})^{(5)}\right)(q_{29})^{(5)}G_{29}^{*} + (a_{29})^{(5)}(q_{28})^{(5)}G_{28}^{*}\right)\right]$ $\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(29)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(29)}T_{29}^{*}\right)$ $+\left(\left((\lambda)^{(5)} + (a_{29}^{'})^{(5)} + (p_{29})^{(5)}\right)(q_{28})^{(5)}G_{28}^{*} + (a_{28})^{(5)}(q_{29})^{(5)}G_{29}^{*}\right)$ $\left(\left((\lambda)^{(5)} + (b_{28}^{'})^{(5)} - (r_{28})^{(5)}\right)s_{(29),(28)}T_{29}^{*} + (b_{29})^{(5)}s_{(28),(28)}T_{28}^{*}\right)$	

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^2 + \left((b'_{28})^{(5)} + (b'_{29})^{(5)} - (r_{28})^{(5)} + (r_{29})^{(5)}\right) (\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^2 + \left((a'_{28})^{(5)} + (a'_{29})^{(5)} + (p_{28})^{(5)} + (p_{29})^{(5)}\right) (\lambda)^{(5)}\right) (q_{30})^{(5)} G_{30}$$

$$+\left((\lambda)^{(5)} + (a'_{28})^{(5)} + (p_{28})^{(5)}\right) \left((a_{30})^{(5)} (q_{29})^{(5)} G^*_{29} + (a_{29})^{(5)} (a_{30})^{(5)} (q_{28})^{(5)} G^*_{28}\right)$$

$$\left(\left((\lambda)^{(5)} + (b'_{28})^{(5)} - (r_{28})^{(5)}\right) s_{(29),(30)} T^*_{29} + (b_{29})^{(5)} s_{(28),(30)} T^*_{28}\right)\} = 0$$

+

$$\left((\lambda)^{(6)} + (b'_{34})^{(6)} - (r_{34})^{(6)}\right)\{\left((\lambda)^{(6)} + (a'_{34})^{(6)} + (p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)}\right)(q_{33})^{(6)} G^*_{33} + (a_{33})^{(6)} (q_{32})^{(6)} G^*_{32}\right)\right]$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(33)} T^*_{33} + (b_{33})^{(6)} s_{(32),(33)} T^*_{33}\right)$$

$$+\left(\left((\lambda)^{(6)} + (a'_{33})^{(6)} + (p_{33})^{(6)}\right)(q_{32})^{(6)} G^*_{32} + (a_{32})^{(6)} (q_{33})^{(6)} G^*_{33}\right)$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(32)} T^*_{33} + (b_{33})^{(6)} s_{(32),(32)} T^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^2 + \left((b'_{32})^{(6)} + (b'_{33})^{(6)} - (r_{32})^{(6)} + (r_{33})^{(6)}\right) (\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^2 + \left((a'_{32})^{(6)} + (a'_{33})^{(6)} + (p_{32})^{(6)} + (p_{33})^{(6)}\right) (\lambda)^{(6)}\right) (q_{34})^{(6)} G_{34}$$

$$+\left((\lambda)^{(6)} + (a'_{32})^{(6)} + (p_{32})^{(6)}\right) \left((a_{34})^{(6)} (q_{33})^{(6)} G^*_{33} + (a_{33})^{(6)} (a_{34})^{(6)} (q_{32})^{(6)} G^*_{32}\right)$$

$$\left(\left((\lambda)^{(6)} + (b'_{32})^{(6)} - (r_{32})^{(6)}\right) s_{(33),(34)} T^*_{33} + (b_{33})^{(6)} s_{(32),(34)} T^*_{32}\right)\} = 0$$

+

$$\left((\lambda)^{(7)} + (b'_{38})^{(7)} - (r_{38})^{(7)}\right)\{\left((\lambda)^{(7)} + (a'_{38})^{(7)} + (p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)} + (a'_{36})^{(7)} + (p_{36})^{(7)}\right)(q_{37})^{(7)} G^*_{37} + (a_{37})^{(7)} (q_{36})^{(7)} G^*_{36}\right)\right]$$

$$\left(\left((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(37)} T^*_{37} + (b_{37})^{(7)} s_{(36),(37)} T^*_{37}\right)$$

$$+\left(\left((\lambda)^{(7)} + (a'_{37})^{(7)} + (p_{37})^{(7)}\right)(q_{36})^{(7)} G^*_{36} + (a_{36})^{(7)} (q_{37})^{(7)} G^*_{37}\right)$$

$$\left(\left((\lambda)^{(7)} + (b'_{36})^{(7)} - (r_{36})^{(7)}\right) s_{(37),(36)} T^*_{37} + (b_{37})^{(7)} s_{(36),(36)} T^*_{36}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^2+\left((b'_{36})^{(7)}+(b'_{37})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^2+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G^*_{37}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G^*_{36}\right)$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T^*_{37}+(b_{37})^{(7)}s_{(36),(38)}T^*_{36}\right)\}=0$$

$+$

$$\left((\lambda)^{(8)}+(b'_{42})^{(8)}-(r_{42})^{(8)}\right)\{\left((\lambda)^{(8)}+(a'_{42})^{(8)}+(p_{42})^{(8)}\right)$$

$$\left[\left(\left((\lambda)^{(8)}+(a'_{40})^{(8)}+(p_{40})^{(8)}\right)(q_{41})^{(8)}G^*_{41}+(a_{41})^{(8)}(q_{40})^{(8)}G^*_{40}\right)\right]$$

$$\left(\left((\lambda)^{(8)}+(b'_{40})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(41)}T^*_{41}+(b_{41})^{(8)}s_{(40),(41)}T^*_{41}\right)$$

$$+\left(\left((\lambda)^{(8)}+(a'_{41})^{(8)}+(p_{41})^{(8)}\right)(q_{40})^{(8)}G^*_{40}+(a_{40})^{(8)}(q_{41})^{(8)}G^*_{41}\right)$$

$$\left(\left((\lambda)^{(8)}+(b'_{40})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(40)}T^*_{41}+(b_{41})^{(8)}s_{(40),(40)}T^*_{40}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2+\left((a'_{40})^{(8)}+(a'_{41})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$\left(\left((\lambda)^{(8)}\right)^2+\left((b'_{40})^{(8)}+(b'_{41})^{(8)}-(r_{40})^{(8)}+(r_{41})^{(8)}\right)(\lambda)^{(8)}\right)$$

$$+\left(\left((\lambda)^{(8)}\right)^2+\left((a'_{40})^{(8)}+(a'_{41})^{(8)}+(p_{40})^{(8)}+(p_{41})^{(8)}\right)(\lambda)^{(8)}\right)(q_{42})^{(8)}G_{42}$$

$$+\left((\lambda)^{(8)}+(a'_{40})^{(8)}+(p_{40})^{(8)}\right)\left((a_{42})^{(8)}(q_{41})^{(8)}G^*_{41}+(a_{41})^{(8)}(a_{42})^{(8)}(q_{40})^{(8)}G^*_{40}\right)$$

$$\left(\left((\lambda)^{(8)}+(b'_{40})^{(8)}-(r_{40})^{(8)}\right)s_{(41),(42)}T^*_{41}+(b_{41})^{(8)}s_{(40),(42)}T^*_{40}\right)\}=0$$

$+$

$$\left((\lambda)^{(9)}+(b'_{46})^{(9)}-(r_{46})^{(9)}\right)\{\left((\lambda)^{(9)}+(a'_{46})^{(9)}+(p_{46})^{(9)}\right)$$

$$\left[\left(\left((\lambda)^{(9)}+(a'_{44})^{(9)}+(p_{44})^{(9)}\right)(q_{45})^{(9)}G^*_{45}+(a_{45})^{(9)}(q_{44})^{(9)}G^*_{44}\right)\right]$$

$$\left(\left((\lambda)^{(9)}+(b'_{44})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(45)}T^*_{45}+(b_{45})^{(9)}s_{(44),(45)}T^*_{45}\right)$$

$$+\left(\left((\lambda)^{(9)}+(a'_{45})^{(9)}+(p_{45})^{(9)}\right)(q_{44})^{(9)}G^*_{44}+(a_{44})^{(9)}(q_{45})^{(9)}G^*_{45}\right)$$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(44)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(44)}T_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$\left(\left((\lambda)^{(9)}\right)^{2}+\left((b_{44}^{'})^{(9)}+(b_{45}^{'})^{(9)}-(r_{44})^{(9)}+(r_{45})^{(9)}\right)(\lambda)^{(9)}\right)$

$+\left(\left((\lambda)^{(9)}\right)^{2}+\left((a_{44}^{'})^{(9)}+(a_{45}^{'})^{(9)}+(p_{44})^{(9)}+(p_{45})^{(9)}\right)(\lambda)^{(9)}\right)(q_{46})^{(9)}G_{46}$

$+\left((\lambda)^{(9)}+(a_{44}^{'})^{(9)}+(p_{44})^{(9)}\right)\left((a_{46})^{(9)}(q_{45})^{(9)}G_{45}^{*}+(a_{45})^{(9)}(a_{46})^{(9)}(q_{44})^{(9)}G_{44}^{*}\right)$

$\left(\left((\lambda)^{(9)}+(b_{44}^{'})^{(9)}-(r_{44})^{(9)}\right)s_{(45),(46)}T_{45}^{*}+(b_{45})^{(9)}s_{(44),(46)}T_{44}^{*}\right)\}=0$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

Note: **Same dovetailing explanation holds good for d/dt (partial differential with respect to t), d/dt,d^2/dt^2 (acceralation: double dot). Such an exposition is helpful in optimisation problems, duality of motion, wave motion a homogeneous functions studies, and control theory which we intend to incorporate in future**.

SECTION THIRTY EIGHT

Non-Standard Higgs Searches And Precision Higgs Measurements

INTRODUCTION—VARIABLES USED

Complementarity Between Non-Standard Higgs Searches and Precision Higgs Measurements in the MSSM Marcela Carena, Howard E. Haber, Ian Low, Nausheen R. Shah, Carlos E. M. Wagner

(1) Precision measurements of the Higgs boson properties at the LHC provide (eb) relevant constraints on possible weak-scale extensions of the Standard Model (SM).
(2) In the context of the Minimal Supersymmetric Standard Model (MSSM) these constraints seem to suggest (eb) that all the additional, non-SM-like Higgs bosons should be (=) heavy, with masses larger than about 400 GeV.
(3) This article shows that such results do not hold when (e) the theory approaches (e&eb) the conditions for "alignment independent of decoupling", where (e) the lightest CP-even Higgs boson has (e) SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses.
(4) The combination of current bounds from (e) direct Higgs boson searches at the LHC, along with (e&eb) the alignment conditions, have (e) a significant impact on (e&eb) the allowed MSSM parameter space yielding (eb) light additional Higgs bosons.
(5) In particular, after ensuring the correct mass for the lightest CP-even Higgs boson, authors find that (eb) precision measurements and direct searches are (=) complementary, and may soon be able to probe the region of (e) non-SM-like Higgs boson with (e&eb) masses below the top quark pair mass threshold of 350 GeV and low to moderate values of tanβ. Subjects: High Energy Physics -

Phenomenology (hep-ph); High Energy Physics - Experiment (hep-ex) Journal reference: Phys. Rev. D 91, 035003 (2015) DOI: 10.1103/PhysRevD.91.035003 Report number: EFI-14-36, FERMILAB-PUB-14-392-T, MCTP-14-37, SCIPP 14/16 Cite as: arXiv:1410.4

Preserving the validity of the Two-Higgs Doublet Model up to the Planck scale Pedro Ferreira, Howard E. Haber, Edward Santos

(6) Authors examine the constraints (e) on the two Higgs doublet model (2HDM) due to (e) the stability of the scalar potential and absence of Landau poles at (eb) energy scales below the Planck scale.

(7) Authors employ the most general 2HDM that incorporates (e) an approximately Standard Model (SM) Higgs boson with (e&eb) a flavor aligned Yukawa sector to eliminate (e) potential tree-level Higgs-mediated flavor changing neutral currents.

(8) Using basis independent techniques, they exhibit (eb) robust regimes of the 2HDM parameter space with a 125 GeV SM-like Higgs boson that is (=) stable and perturbative up to (e) the Planck scale.

(9) Implications for the heavy scalar spectrum are exhibited. Subjects: High Energy Physics - Phenomenology (hep-ph) Journal reference: Phys. Rev. D 92, 033003 (2015) DOI: 10.1103/PhysRevD.92.033003 Report number: SCIPP-15/07 Cite as: arXiv:1505.04001 [hep-ph] (or arXiv:1505.04001v2 [hep-ph] for this version)

NOTATION

Module One

Precision measurements of the Higgs boson properties at the LHC provide (eb) relevant constraints on possible weak-scale extensions of the Standard Model (SM)

G_{13} : Category one of Precision measurements of the Higgs boson properties at the LHC

G_{14} : Category two of SAS

G_{15} : Category three of SAS

T_{13} : Category one of relevant constraints on possible weak-scale extensions of the Standard Model (SM)

T_{14} : Category two of SAS

T_{15} : Category three of SAS

Module Two

In the context of the Minimal Supersymmetric Standard Model (MSSM) these constraints seem to suggest (eb) that all the additional, non-SM-like Higgs bosons should be (=) heavy, with masses larger than about 400 GeV

G_{16} : Category one of Minimal Supersymmetric Standard Model (MSSM) these constraints

G_{17} : Category two of SAS

G_{18} : Category three of SAS

T_{16} : Category one of all the additional, non-SM-like Higgs bosons should be (=) heavy, with masses larger than about 400 GeV

T_{17} : Category two of SAS

T_{18} : Category three of SAS	
Module three This article shows that such results do not hold when (e) the theory approaches (e&eb) the conditions for "alignment independent of decoupling", where (e) the lightest CP-even Higgs boson has (e) SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses	
G_{20} : Category one of results do not hold; theory approaches (e&eb) the conditions for "alignment independent of decoupling", where (e) the lightest CP-even Higgs boson has (e) SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses G_{21} : Category two of SAS G_{22} : Category three of SAS	
T_{20} : Category one oftheory approaches (e&eb) the conditions for "alignment independent of decoupling", where (e) the lightest CP-even Higgs boson has (e) SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses; results do not hold T_{21} : Category two of SAS T_{22} : Category three of SAS	
Module four This article shows that such results do not hold when the theory approaches the conditions for "alignment independent of decoupling", where (e) the lightest CP-even Higgs boson has (e) SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses	
G_{24} : Category one of lightest CP-even Higgs boson has (e) SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses G_{25} : Category two of SAS G_{26} : Category three of SAS	
T_{24} : Category one of such results do not hold when the theory approaches the conditions for "alignment independent of decoupling", T_{25} : Category two of SAS T_{26} : Category three of SAS	
Module five This article shows that such results do not hold when the theory approaches the conditions for "alignment independent of decoupling", where the lightest CP-even Higgs boson has (e) SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses	
G_{28} : Category one of SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses	

G_{29} : Category two of SAS G_{30} : Category three of SAS	
T_{28} : Category one of such results do not hold when the theory approaches the conditions for "alignment independent of decoupling", where the lightest CP-even Higgs boson T_{29} : Category two of SAS T_{30} : Category three of SAS	
Module six This article shows that such results do not hold when the theory approaches the conditions for "alignment independent of decoupling", where the lightest CP-even Higgs boson has SM-like tree-level couplings to (e&eb) fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses	
G_{32} : Category one of **such results do not hold when the theory approaches the conditions for "alignment independent of decoupling", where the lightest CP-even Higgs boson has SM-like tree-level couplings;** fermions and gauge bosons, independently of the non-standard Higgs boson masses G_{33} : Category two of SAS G_{34} : Category three of SAS	
T_{32} : Category one of fermions and gauge bosons, independently of (e) the non-standard Higgs boson masses; **such results do not hold when the theory approaches the conditions for "alignment independent of decoupling", where the lightest CP-even Higgs boson has SM-like tree-level couplings** T_{33} : Category two of SAS T_{34} : Category three of SAS	
Module seven The combination of current bounds from direct Higgs boson searches at the LHC, along with (e&eb) the alignment conditions, have (e) a significant impact on (e&eb) the allowed MSSM parameter space yielding (eb) light additional Higgs bosons	
G_{36} : Category one of **current bounds from direct Higgs boson searches at the LHC;** alignment conditions, have (e) a significant impact on (e&eb) the allowed MSSM parameter space yielding (eb) light additional Higgs bosons G_{37} : Category two of SAS G_{38} : Category three of SAS	
T_{36} : Category one of alignment conditions, have (e) a significant impact on (e&eb) the allowed MSSM parameter space yielding (eb) light additional Higgs bosons **;current bounds from direct Higgs boson searches at the LHC**	

T_{37} : Category two of SAS T_{38} : Category three of SAS	
Module eight The combination of current bounds from direct Higgs boson searches at the LHC, along with the alignment conditions, have a significant impact on (e&eb) the allowed MSSM parameter space yielding (eb) light additional Higgs bosons	
G_{40} : Category one of **combination of current bounds from direct Higgs boson searches at the LHC, along with the alignment conditions, have a significant impact;** allowed MSSM parameter space yielding (eb) light additional Higgs bosons G_{41} : Category two of SAS G_{42} : Category three of SAS	
T_{40} : Category one of allowed MSSM parameter space yielding (eb) light additional Higgs bosons; **combination of current bounds from direct Higgs boson searches at the LHC, along with the alignment conditions, have a significant impact** T_{41} : Category two of SAS T_{42} : Category three of SAS	
Module Nine The combination of current bounds from direct Higgs boson searches at the LHC, along with the alignment conditions, have a significant impact on the allowed MSSM parameter space yielding (eb) light additional Higgs bosons	
G_{44} : Category one of combination of current bounds from direct Higgs boson searches at the LHC, along with the alignment conditions, have a significant impact on the allowed MSSM parameter space G_{45} : Category two of SAS G_{46} : Category three of SAS	
T_{44} : Category one of light additional Higgs bosons T_{45} : Category two of SAS T_{46} : Category three of SAS	

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